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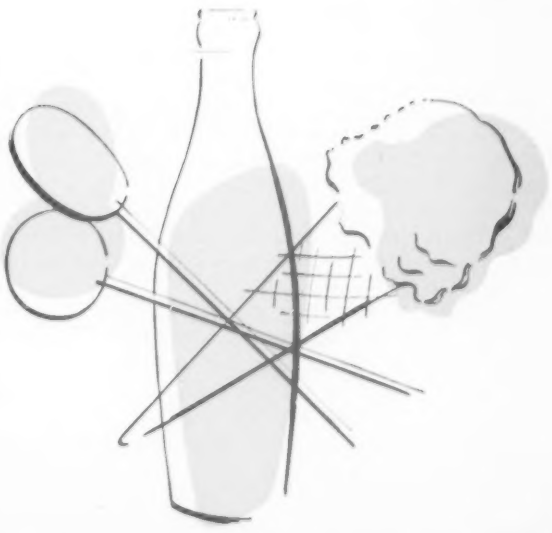

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Affairs of the Institute

Annual Meeting Bulletin Board
News of the Regional Sections
Personnel
Newly Elected Members of IFT
Books
Selected Abstracts
Future Meetings
Food Industry Topics

Annual Meeting Bulletin Board

It's Columbus, Ohio, June 12-16, 1955

Last Call for Papers. All those who wish to contribute to the 1955 IFT meeting are reminded that titles and a statement concerning papers must be in by November 15 although final abstracts do not have to be in until February 1, 1955. Detailed instructions are in the September issue of FOOD TECHNOLOGY. Contributions should be sent to F. E. Deatherage, Department of Agricultural Biochemistry, The Ohio State University, Columbus 10, Ohio.

The Ohio Valley — Where Industry and Agriculture Meet. Ohio is known as the Mother of Presidents and the gateway to the West. But to those in the food field it might well be known as the focus of the food industry. This will be immediately apparent to all who come to the 1955 IFT meeting in Columbus. Ohio is strategically located where the industrial East as typified in the Upper Ohio Valley meets the great agricultural West. Consequently, besides being highly industrialized with numerous large cities, Ohio is among the top agricultural states. Columbus is situated in the center of vast numbers of food producers and food consumers. It is little wonder then that within a mere 200-mile radius of the 1955 Convention City almost any interest of the food technologist may be satisfied.

Large areas of Ohio and the Ohio Valley are used in producing a wide variety of fruits and vegetables for both the fresh and processed market. Indeed this is the area in which Johnny Appleseed did his pioneering work. There are a large number of small and large canning plants devoted to such items as tomatoes, tomato juice and products, corn, pumpkin, apples, peaches and grape products. There are several major operations specializing in preserves, jellies, and jams. One of the most modern canning plants is devoted to the production of Chinese foods. High quality wines produced in modern wineries are along the shores of Lake Erie and along the Ohio River.

Whereas legend relates New England with maple syrup, Ohio abounds in "sugar bushes." This delightful pancake dressing is produced in large quantities over the area.

Potatoes are another major crop. In addition to production for the fresh market, Ohio growers are heavy suppliers to the potato products industry—notably, the potato chip industry.

What of the fats? Ohio is the center of operations of one of the world's leaders in fat and oil technology. In addition a number of other fat and oil processors have large operations in the area.

The cow thrives on Ohio Valley grass and the dairy market is one of the richest. Pioneering trends in fresh milk marketing and processing are found here. In addition the area leads in the production of high quality proprietary baby foods. Some of the more unique and modern dairy products originated and are produced here. The classical dairy products also hold their own —cheese is outstanding—particularly Swiss, and there are also large continuous butter operations.

Modern large and small meat packing plants are spread over the area supplying local and nationwide taste for good fresh and processed meat. Much of the meat is produced on Ohio Valley farms.

The nation's sweet-tooth is not forgotten. Sugar beets are produced and the sugar is refined here. Then numerous large and small candy plants are to be found here—one of the most modern produces over a million pounds a week.

High quality soft wheat is produced and milled in Ohio. In addition to a large number of very modern bread bakeries some of the most efficient and modern biscuit and cracker shops are to be found here.

This area is not without the most modern brewing facilities and some of the major distillers are headquartered in the Valley. Their research laboratories and production facilities are of the most modern imaginable.

Coffee is roasted in extensive amounts and one of the leaders of instant coffee production is here. Then too, such plants as spice grinding, bean packing, peanut butter, kraut, pickles and soft drinks are numerous.

Food merchandising as such is on a very high plane, a number of small chains and one of the largest are headquartered here. In fact, Columbus boasts one of the very first successful supermarkets.

Packaging is a prime consideration of every food technologist. America's major tin-plate production is found along the Ohio River and can fabricators are many. Three of the largest glass container manufacturers have their headquarters in the area as well as research and production facilities. The main plant and laboratories of one of the major flexible package concerns is a short distance from Columbus right handy to film and paper mills located also in this area which is shared with the chemical industry of the upper Ohio Valley.

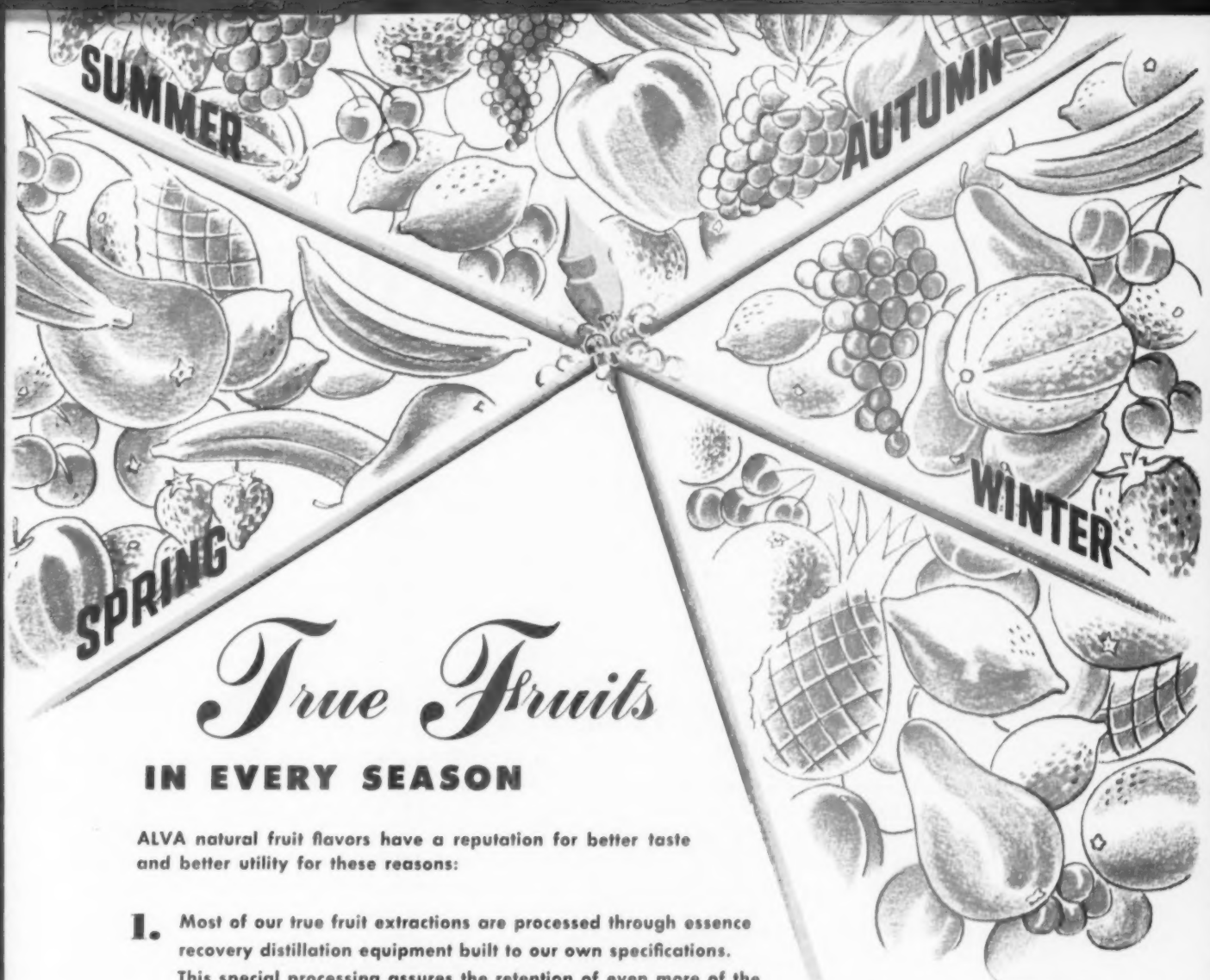
Members of IFT will find their primary food interests right at their beck and call at Columbus, site of the gathering of the food clans in 1955. The Ohio Valley Section will be looking for you in Columbus, June 12-16, 1955.

Regional Section News

NORTHERN CALIFORNIA SECTION

Never stuck for ideas, the July-August issue of the Section's *Hornblower* is a special vacation issue "dedicated to right handed thumb lickers." You start at the back and read to the front. Following this unique formula, we learned that Dr. George F. Garnatz, Director of Kroger Foundation at Cincinnati, and Chairman of the Ohio Section of IFT, hosts of the 1955 National Meeting at Columbus, spoke to the Northern Californians on July 15, bringing them up to date on

(Continued on page 5)



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The Vital Story of MARGARINE FORTIFICATION

How They Made Margarine a Better Food

by Science Writer

Over a hundred million pounds of margarine are used a month as a table spread, a tasty seasoning for hot vegetables and for many other purposes in cooking and baking. Included in the "Basic 7" food list, it serves as one of the finest and most concentrated energy foods. It is a shining example of a food which has been made repeatedly better.

In the original product which was invented more than 80 years ago, beef fats were used. Later these were replaced by lard and then by vegetable oils. When raw the latter, however, had several drawbacks: an unpleasant odor and taste, unsatisfactory color and a low melting point. These have been overcome by scientific refining methods, hydrogenation and use of certified food colors. Strictly phrased Federal Standards sponsored by the industry assure maintenance of very high quality, uniformity and nutritional value.

With this history of product improvement, it was natural that margarine makers would make their food a more valuable one by the addition of vitamin A. For over a decade many brands of table margarine were marketed with a label statement that they contained 9,000 International Units of vitamin A per pound. Now virtually all brands are fortified with vitamin A and the minimum amount supplied per pound is 15,000 I.U., an increase of over 66%.

Here are some of the benefits which vitamin A supplies. Scientific evidence is available showing that it helps to maintain normal vision and to overcome night blindness; that it increases the body's resistance to infections; that it promotes physical and mental development; and that it aids in maintaining normal glandular function.

Margarine makers who were accustomed to "fishy" odors and flavors when buying vitamin A sought a new source of supply. They found this new source in synthetic vitamin A—as produced by the famous synthesis evolved by the Roche research team headed by Dr. Otto Isler.

It was natural that margarine makers would adopt synthetic vitamin A for fortification of their products. When they were dependent on vitamin A extracted from fish liver sources, they found wide variations in vitamin A price. Synthetic vitamin A eliminated this disadvantage because its price is reasonable and stable. And a second disadvantage disappeared because synthetic vitamin A has absolutely no "fishy" odor, or taste, or after-taste!

Pure vitamin A and concentrates of it, produced by the Roche synthesis, have been approved by the Food and Drug Administration for use in margarine and other foods. It is light and clear in color.

Starting with citral, obtained from lemon grass oil, Roche vitamin A is built up through twelve manufacturing operations into a molecule identical with Nature's own.

At the huge Roche Park plant of Hoffmann-La Roche over 500 pieces of large-scale chemical engineering equipment in a multi-million dollar plant are working constantly to produce the superior Roche vitamin A.

Again, a development by the Roche people, who manufacture not only vitamin A but many other essential vitamins by the tons, has contributed to the making of a more nutritious food—and thus to the public welfare.

This article, reprints of which are available without charge, is published as a service to the food industry by Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West, Montreal, Quebec.

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REGIONAL SECTION NEWS

(Continued from page 2)

the "Homemakers Reference Committee of the Kroger Foundation." Then on August 12 at the Merchandise Mart, Leonard Farber, Associate Professor of Mechanical Engineering at the University of California, addressed the Section on "Flow Problems in the Food Industry."

AUSTRALIA NORTHERN SECTION

The Fourth Annual Meeting of the Australia Northern Section was held in the staff room at the C.S.I.R.O. Division of Food Preservation in Sydney. As usual, the meeting was preceded by a buffet dinner. The Secretary's Annual Report drew attention to the continued steady growth of the Section the membership of which is now almost one hundred.

The election of officers for the coming year was concluded, and the new slate reads:

Chairman: W. W. Hopkins (Henry Jones Ltd.)
Vice-Chairman: J. F. Kefford (C.S.I.R.O.)
Secretary: V. M. Lewis (Henry Lewis & Sons Pty. Ltd.)
Treasurer: E. G. Davis (C.S.I.R.O.)
Councillor: A. T. Roche (W. H. Brookhouse Pty. Ltd.)
Committee: F. H. Reuter (N.S.W. Univ. of Technology)
H. Govers (Tooheys Standard Brewery Ltd.)
S. M. Sykes (N.S.W. Dept. of Agriculture)
G. Miller (Kia-Ora Industries Ltd.)
E. Hart (James Stedman Hendersons Ltd.)
J. K. J. Roche (Tooheys Standard Brewery Ltd.)

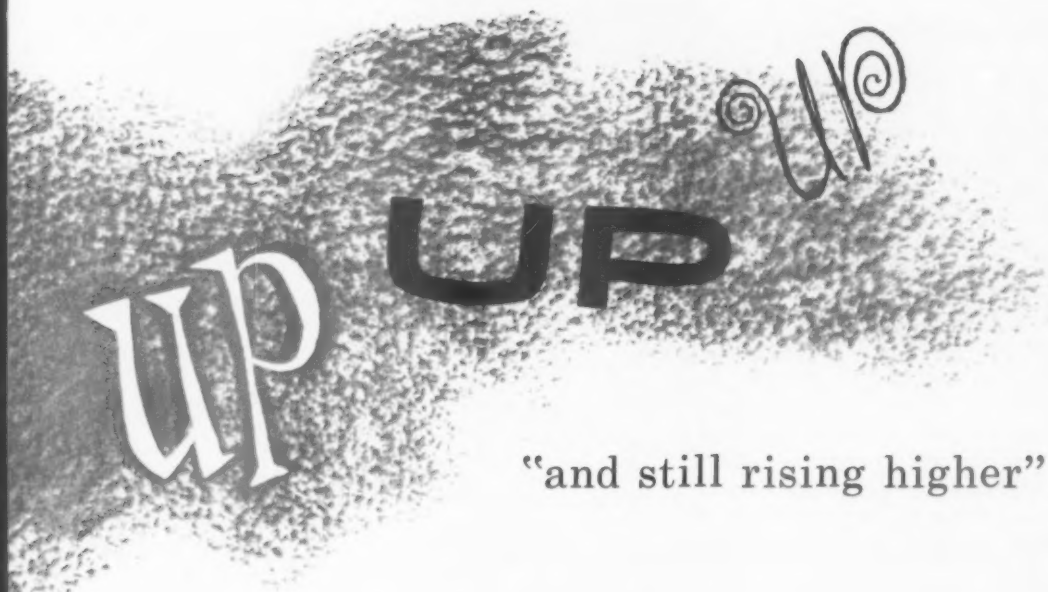
The main business of the evening was an address by Dr. V. M. Lewis who has recently returned from an F.A.O. mission to Yugoslavia. Dr. Lewis discussed the state of the canning industry in Yugoslavia with special reference to can-making facilities and agricultural problems. The talk was followed by some home-spun movies of the country and its people.

DIXIE SECTION

On Friday, August 27, 1954, the Section met at the Georgia Experiment Station, Experiment, Georgia for a visit and tour through the departments of home economics, dairy, horticulture, and food processing. Later in the same afternoon the group toured the Pomona Products Co. at nearby Griffin to observe the unique methods developed by that company for processing pimiento peppers, their main product. The dinner meeting was held on the lawn in front of the Food Processing Building. After dinner, in the auditorium of the Stuckey Building, the group was welcomed by Dr. F. F. Cowart, Resident Director of the Station, and then listened to a report by Dr. J. G. Woodroof on the program of technical papers and activities given at Los Angeles in June. The outline of activities for the coming year, presented by Mr. Barney Hilton, was well received.

PERSONNEL

PROFESSOR MILO D. APPLEMAN, chairman of the Department of Bacteriology, the University of Southern California, is taking his sabbatical year in Aberdeen, Scotland. He will observe and participate in the work being done at the food research center there, his special interests being fishery and dairy products.



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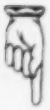
If it's facts you're lacking, we'll be happy to supply them. Write for your free copy of the booklet, "Making the Most of the Dietetic Market with SUCARYL." Chemical Sales Division, Abbott Laboratories, North Chicago, Illinois. Abbott



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We've been producing a lot of different types of distilled monoglycerides for some time now from all sorts of fats, oils, and fatty acids. We sell them under the trade-mark "Myverol" to the shortening, margarine, ice cream, baking, and other food industries where a highly purified, effective, and wholesome emulsifier is what they want.

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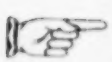

We'd like to custom-make monoglycerides for you from your own fats, using our molecular stills, our other production facilities, and our technical experience to do the job. We can handle the job just about any way you want. Like this, say: You send us a fat. We convert it to distilled monoglycerides, using our own glycerine if you wish, and ship the finished product wherever you choose. You pay only for the work done, glycerine used, and shipping costs. You'd save on raw materials, get a product of as high quality as our own, get exactly what you want.

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Notes from the makers of
Myvax Vitamin A

What will she do with **vitamin A aldehyde?**

Actually, vitamin A aldehyde is a good source of vitamin A; it is readily absorbed and converted into vitamin A alcohol by normal human beings. But, so are Myvax Vitamin A Acetate and Palmitate, with which our customers are well satisfied.

Recently, vitamin A aldehyde became of interest in a rather unusual way. It seems that even though children suffering from fibrocystic disease of the pancreas can't benefit much from vitamin A acetate, they *can* use the aldehyde, which they readily convert into the alcohol form. Children with celiac disease, on the other hand, show poor utilization of *all* forms of vitamin A. Thus, vitamin A blood-level measurements provide physicians with a new technique for a differential diagnosis of these two diseases.

That we were called upon to supply the vitamin A aldehyde needed in these experiments is not unusual. We're constantly engaged in research in all phases of vitamin A activity and molecular structure.

To help increase man's knowledge of vitamin A is one of our obligations. The other is to serve commercial users promptly and conveniently with Myvax Vitamin A Acetate or Palmitate in bulk or packaged to individual batch requirements of margarine manufacturers as Myvapack Vitamin A. ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York and Chicago • W. M. Gillies and Company, Los Angeles and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

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Books

Courtney Robert Hall. HISTORY OF AMERICAN INDUSTRIAL SCIENCE. The Library Publishers, New York, N. Y. Price $4.95.

"One way of looking at technology," writes the author of this stimulating story of the growth of American industrial science, "is to regard it as an enormous extension of human strength." When one considers the growth of American industry from a simple non-specialized type of production into the most ramified and complex and yet the most integrated and successful industrial society in human history, the phrase "an enormous extension of human strength" seems fully justified. In one year, 1952, the United States produced 400,000,000,000 kilowatt hours of electricity, nearly half that produced in the entire world. Add to that the power derived from over 2,000,000,000 barrels of oil, used each year in the U.S.A., and you have without going further a very considerable "extension of human strength."

To achieve our present industrial status, Courtney Hall points out, innumerable specialized technologies have been coordinated and then translated into volume production. Immense energy and ingenuity have gone into the construction of plants and production line equipment. Business ability, scientific talent, labor skills, and individual inventiveness have literally been poured into the great engineering and manufacturing enterprises of America. Coordination of these various factors into an industrial system was achieved in New England and bordering regions by the dawn of the twentieth century. The story of the growth and unification of industry by means of a developing industrial science is told in the early chapters of the book.

To give the prospective reader a complete idea of the wide range of the book would be impossible. The following run-down of some of the high lights may serve, however, as a "sampling" of its content and approach.

The most remarkable characteristic of the twentieth century is speed, asserts the author, in a section on the transportation industry. He covers—among many other topics—the advent of the Diesel locomotive which is steadily replacing the coal or oil burners on the railroad lines of America. With regard to water transportation, he relates the story of the Great Lakes and the tapping of the great productive areas of the West—the iron ore range in Minnesota, for example, and the wheat production of the upper Middle West, for another. The immense developments in aircraft are described—the magnificent new transport planes that contract distances that yesterday were a matter of weeks into a matter of hours.

In describing "the new world of chemicals" the author calls attention at many points to the various occupations and professions that are dependent upon its progress. For example, hitherto unsolved medical problems have been virtually written from the books by chemical means. One need mention only the sulfa drugs, insulin, the antibiotics, and cortisone—all products of the biochemical laboratories. Not all of these are American discoveries. But American industrial science has without question either brought them to the stage of volume production or contributed importantly to this vital accomplishment.

The enormous build-up in the electrical and electronic industries is another fascinating chapter in Hall's book. Here again are industries which touch the many occupations and professions by which Americans live. The advances in experimental electronics are to this reviewer of particularly great interest. Progress in the control and safeguarding of transportation equipment, specifically, the control of aircraft equipment, by electronic means indicates the surprises yet in store. Experimental work in applying electronic radiation to food preservation is only touched upon—rather a disappointment to this reader.

But the progress of other elements of industrial science in the food field leaves little to be desired by those who wish a brief outline of its essential features. The story begins with the application of science to agriculture. In this connection generous and merited praise is extended to the U. S. Department of Agriculture. The great contributions to mechanized agriculture of the farm implement companies are also described. In ten years—1941-51—farm production increased 29% and farm population decreased by 5,000,000. What more need be said to epitomize the triumphs of industrial and agricultural science?

Scientific progress in the design and manufacture of food is reported by a skillful combination of two subject matters—(1) advances in nutrition, chemical engineering, bacteriology, packaging, refrigeration, and manufacturing, and (2) the rise and growth of the various branches of the great food industry. "Meat From Hoof To Market" contains a wealth of facts, concisely presented, on meat production. The role of Chicago, as meat packer for the world, is told. "The Perfect Food" covers the progress made on milk products. The states of Wisconsin, Ohio, and Illinois, as would be expected, are shown to be particularly active in dairy science and manufacturing research. "The Staff of Life" forms a third phase of the history of industrial food science. Another great midwestern industrial center, Minneapolis, features in this brief account of the advances made in the science and technology of cereals and baked products. The citrus branch of the food industry—from Florida, through Texas, to California—is given attention. The story of food packaging and of the container industry as a whole is narrated. For good measure, numerous subsidiary enterprises, such as soap making, are written up. It stands forth in this chapter on the food industry that, to paraphrase: Westward the course of industrial food science takes it way. In view of the extensive growing areas that begin with the western slopes of the Alleghanies and end at the shores of the Pacific, this has been an inevitable trend.

In a concluding chapter, the role of industrial science in national defense, is described. Out of this highly important chapter, I quote the following: "What seems to be the most valuable lesson of all (from World War II) is the final proof, if proof were needed, of the

(Continued on page 14)

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GRAVURE. Matter to be reproduced is etched below the surface of the cylinder, with cells varying in size, not in depth. Ink actually builds up on the surface of paper, cellophane and other materials to give a brilliance and range of values unmatched by other high-speed processes.

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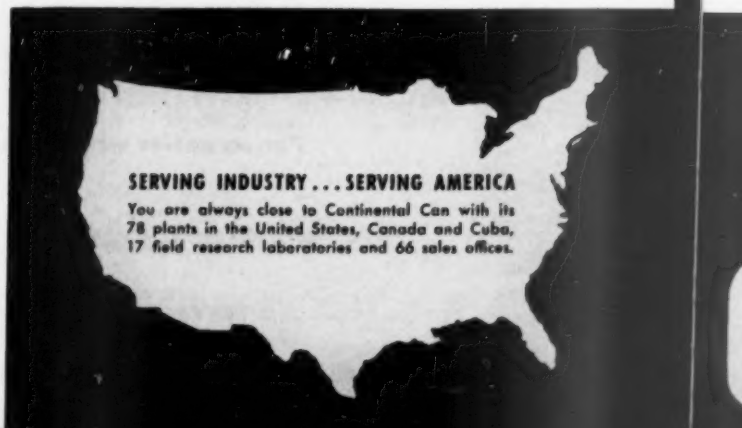
(This advertisement originally appeared in full-color in TIME, BUSINESS WEEK and FORTUNE.)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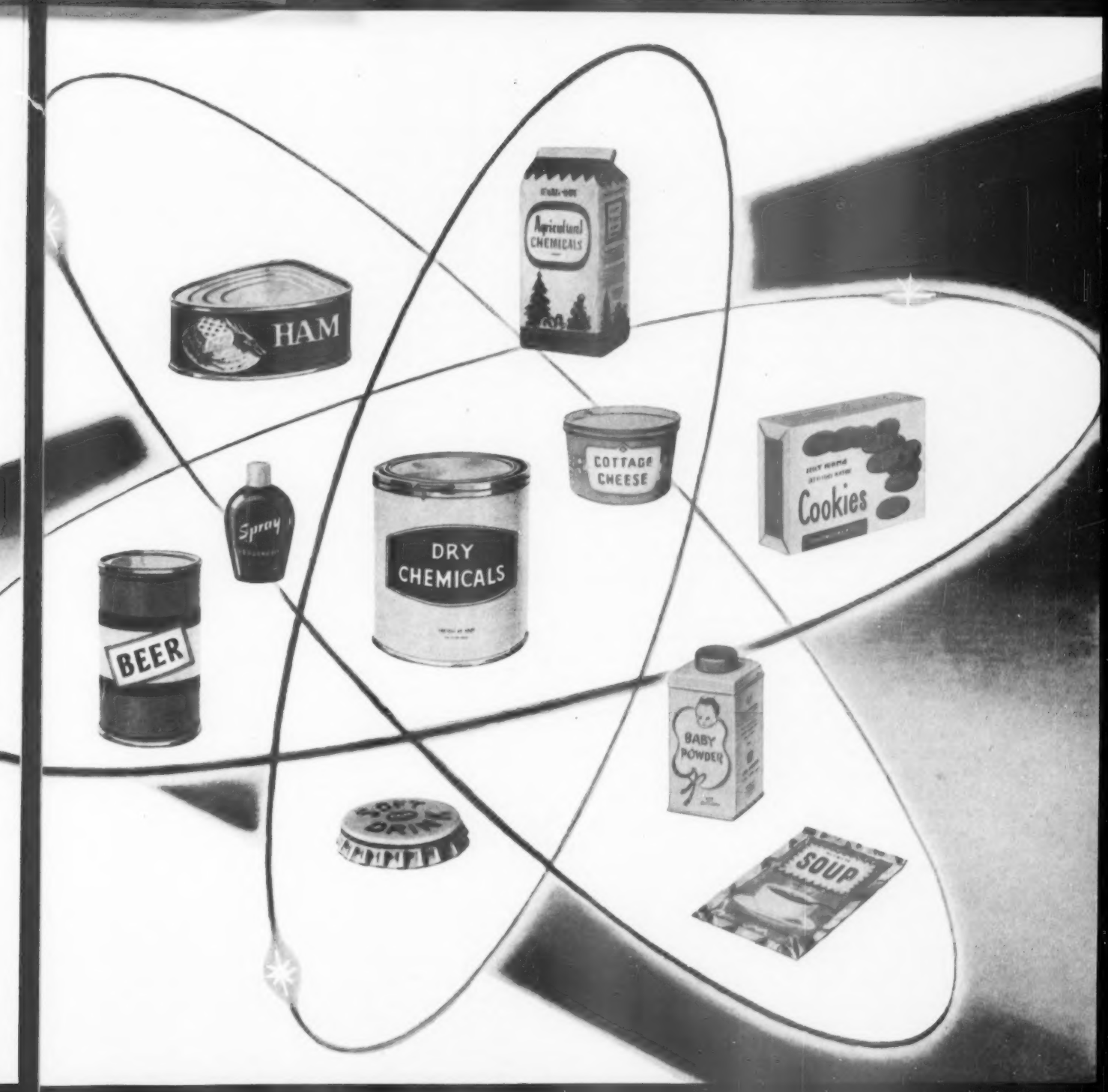

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BOOKS

(Continued from page 10)

effectiveness of a team composed of scientists, the industrialists, and the Military, supported by the determined workers of America."

It seems crystal clear that in this troubled century the combined strength of men in the laboratories, in the industrial plants, and in the Armed Forces must be enlisted, not in fancy but in fact, for defense activities in peacetime. Hall's important book indicates, on the basis of our past experience, how necessary it is to keep industrial science and industrial power continuously coordinated with national defense. The food and container industries, fortunately, are already substantially organized for this purpose.

J. D. Peterman
Col., QMC, USA
Quartermaster Food and Container
Institute for the Armed Forces
Chicago, Illinois.

Practical Mycology. Manual for Identification of Fungi. By Segurd Funder. Published by Broggers Bokter. Forlag, Oslo, Norway. No date.

In the preface the author states that this book is designed to serve as an introduction to mycology for beginners and as an aid for those who, without any special botanical knowledge, are interested in identifying the most common fungi they meet in the course of their work. He further states that the book should be of particular interest to bacteriologists, physicians, veterinary surgeons, bio-chemists, pharmacists, workers in the fermentation industry, the food industry, and agriculture. This is indeed a big order and one that, in the reviewer's opinion, has not been fulfilled.

The author further states in the preface, that a steady increase of mycological lierature demands greater and greater specialization in this branch of science and makes it more and more unapproachable to non-mycologists. This is certainly true, but unfortunately the author himself has not indicated some of the recent literature so important in certain of the areas covered by his book.

It is doubtful if the book can be useful to the beginner as indicated by the author. While there is certainly a need for such a book, it must be presented in such a manner that the beginner will be, at best, subjected to a minimum, rather than considerable confusion. For example, on page 13 some space is devoted to the cross walls of the hypae. Then a statement is made that "some fungi, however, do not develop cross-walls and these are said to be nonseptate." The use of the word "some" in this case is confusing. Actually quite a large number of fungi do not develop septa, whereas the presentation in the book indicates nonseptate fungi are relatively unimportant and rather uncommon. Although the illustrations throughout the book are ideal, they are unrealistic. I recall vividly my beginning studies in mycology—attempting to find under the microscope what I saw in ideal drawings such as those presented in this book. I was frustrated and completely at a loss to know with what I was dealing. Perhaps photographs would have been better.

On page 21, the drawing in figure 4 of *Chlamydospores* are properly indicated with thick walls. On page 20, in figure 22, however, cells with thick walls are shown and the word *Blastospore* is printed in the middle of the drawings of budding yeast cells. Below are the words "budding cells." No explanation is given of these thick wall cells. It is doubtful if a beginner would understand from these drawings the meaning of the terms *Blastospore* or "budding cell" or the relation of one to the other. On page 27 the ascomycetes are divided into two sub-classes; it is indicated that the *Hemiascomycetes* lack an *Ascocarp* and that the asci occur irregularly distributed in the *Mycelia* mass. This statement is certainly confusing insofar as yeasts are concerned. Many of them do not form *Mycelia*. Most mycologists include yeast in the *Hemiascomycetes* but not because they form *Mycelia*.

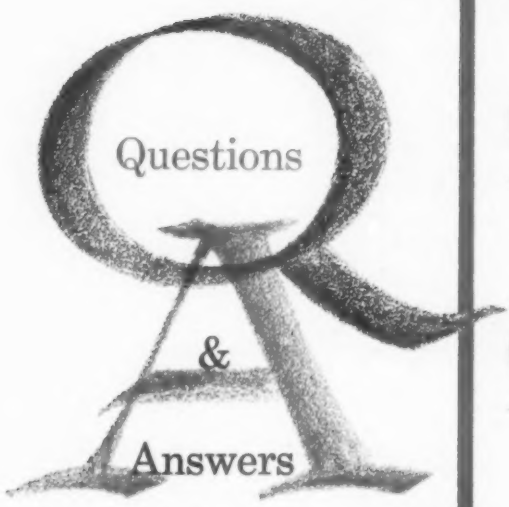
On page 28, the *fungi imperfecti* are broken down into four classes leaving no place for the yeast; yet on page 129 reference is made to the work of Buchwald who introduced the order *Torulopsidales* for imperfect yeast. It is quite astounding to see any treatment of the yeast without reference to the monumental work of Lodder and Kreager-Van Rij, entitled *The Yeast—A Taxonomic Study*, published in 1952. In this book, reference is made to Buchwald's inclusion of imperfect yeast in the order *Torulopsidales*, but the order nomenclature is changed from *Torulopsidales* to *Cryptococcales*.

On page 52, reference is made to *Taphrina* with an indication that an illustration occurs on page 106. The illustration on page 106, however, is only of that of the fungus in the parasitic stage. There is no information to indicate to the beginner that when this organism is grown on an agar plate it looks exactly like yeast and it would probably be classified as *Candida pulcherrima*.

One page 57, there is a brief treatment of the families *Rhodotorulaceae* and *Sporobolmycetaceae*. The statement is made that these are yeast-like forms which seem to be derived from the *Basidiomycetes*, that they are non-fermentative and possess *Carotinoid* pigments. The most important characteristic of the family *Sporobolmycetaceae (ballistospores)* is omitted. Furthermore, a procedure for the detection of *Ballistospores* is lacking. In the illustration it is indicated, however, that spores are explosively propelled from the sterigma when matured. The statement that *Carotinoid* pigments occur in these organisms would lead one to believe that they are all pink, red, or yellow in color. Certainly this is not true, for the genus *Bullera* (a member of the *Sporobolmycetaceae*) is characterized by the absence of *Carotinoid* pigments.

An illustration of mucor is given on page 79 and an example of a *columella* is shown. However, no explanation is given of just what a *columella* is. In the lower right hand corner of page 79 is given an illustration of various phases of *Coccidioides*. In such an illustration it might be well to indicate that *Sphaerules* can occur in the cultural phase and unusual conditions. On

(Continued on page 16)



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Q **Just what is meant by "coated?"**

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Q **What can PY-RAN do for me?**

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Q **How will this stability affect the shelf life of my products?**

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Q **How will this greater stability affect the release of CO_2?**

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Q **What other advantages has PY-RAN?**

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Q **Can PY-RAN be used in conjunction with other phosphate leavening agents?**

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Q **How can I find out more about PY-RAN?**

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Monsanto SAPP-28 . . . a slow-action baking acid

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BOOKS

(Continued from page 14)

page 81, the statement is made "it is too difficult to routinely culture *Pityrosporum ovale*." The reviewer has grown this organism for years in culture without the slightest amount of difficulty when a satisfactory medium was used, i. e. that described by Benham.

The taxonomic presentation in the table at the end of the book is an excellent idea; however, in preparing it the printers were completely inconsiderate of those who may be nearsighted or require bifocals for reading. In short, the printing is too small to be very useful.

It is apparent that the reviewer is not very enthusiastic about the book and certainly is of the opinion that it may misinform the beginner more than inform him. It will be placed on the shelf reserved for books not recommended for use.

EMIL MRAK
Davis, California

Selected Abstracts*

ANALYTICAL METHODS

Identification and determination of non-nitrogenous organic acids of sugar cane by partition chromatography.

ROBERTS, E. J., AND MARTIN, L. F. *Anal. Chem., 26,* 815-18 (1954).

Application of partition chromatography on silicic acid columns of large capacity has made it possible to isolate and identify all of the hitherto undetected non-nitrogenous org. acids present in sugar cane juices. These included mesaconic and fumaric acids as well as succinic acid, which was not adequately identified in earlier work. The method also permits more satisfactory confirmation of the malic, oxalic, citric, and glycollic acids.

Improved chromatographic method for analysis of sugar beet products.

SERRO, F. R., AND BROWN, R. J. *Anal. Chem., 26,* 890-2 (1954).

Paper chromatographic methods are described for raffinose, inositol and galactinol.

Measurement of butyric acid in fat with reference to the detection of substitute fats in dairy products.

HARPER, W. J., AND ARMSTRONG, T. V. *J. Dairy Sci., 37,* 481-7 (1954).

A method is presented for the rapid direct chromatographic detn. of the molar concn. of butyric acid in the fat of dairy products which may be utilized as a means of detecting fat substitution in dairy products.

Egg content of noodles.

MUNSEY, V. E. *J. Assoc. Offic. Agr. Chemists, 37,* 408-13 (1954).

The detn. is based on the extn. of the sterol and its pptn. with digitonin.

Chromatographic separation and analysis of mixtures of pyruvic, oxalacetic and alpha-ketoglutaric acids.

ISHERWOOD, F. A., AND CRUICKSHANK, D. H. *Nature, 173,* 121-2 (1954).

A simple chromatographic method for the determination of the saturated straight-chain fatty acids C_{10}-C_{24}.

NIJKAMP, H. J. *Anal. Chim. Acta, 10,* 448-58 (1954).

A silica gel column is used, tinted with a suitable indicator, so that each acid is distinctly visible and only one titration is required for each acid. A description is given of the prepn. of a silica gel, which is highly suitable for this chromatographic analysis.

Volumetric determination of quaternary ammonium compounds and certain tertiary amines.

CARKHUFF, E. D., AND BOYD, W. F. *J. Am. Pharm. Assoc., Sci. Ed., 43,* 240-1 (1954).

A method for the detn. of quaternary NH^+_4 salts and certain tertiary amines is presented. Concns. in the vicinity of 1:4,000 of Ceepryn Chloride, Bentyl Hydrochloride, and similar compds. are readily assayed.

The detection of trichloroethylene in cottonseed oil.

WIESE, G. A., AND JESINA, C. L. *Drug Standards, 22,* 105-7 (1954).

A simple method for qual. detection of trichloroethylene and other chlorinated hydrocarbons in cottonseed oil is submitted. This test is sensitive to about 1:200,000 parts trichloroethylene in cottonseed oil.

Colorimetric method for determination of red blood cell cholinesterase activity in whole blood.

FLEISHER, J. H., AND POPE, E. J. *Arch. Ind. Hyg. and Occupational Med., 9,* 323-34 (1954).

A colorimetric method for the detn. of cholinesterase activity based upon the measurement of acetylcholine remaining after controlled incubation with whole blood is presented.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

On the surface inactivation of pepsin.

CHEESMAN, D. F., AND SCHULLER, H. *J. Colloid Sci., 9,* 113-21 (1954).

A new method is described for the isolation of unimolecular films of protein. Results suggest that a fully unfolded pepsin film possesses no enzymic activity. There is no reason to suppose that a pepsin mol., after having undergone complete unfolding at an air-H_2O interface, can readily regain an active configuration.

A polarographic study of Evans blue and its combination with plasma proteins.

MARKUS, G., AND BAUMBERGER, J. P. *J. Biol. Chem., 206,* 59-65 (1954).

The present study indicates that the azo dye T-1824 is readily reducible at the dropping Hg cathode. The reaction consists of the reduction of the 2 azo groups to hydrazo groups. The observation that the protein-bound T-1824 does not give rise to a polarographic wave furnishes the basis for a new approach to the study of the protein-dye equil.

The distribution of radioactivity in goat casein after injection of radioactive amino acids and its bearing on theories of protein synthesis.

ASKONAS, B. A., CAMPBELL, P. N., AND WORK, T. S. *Biochem. J., 56, IV,* January, 1954.

Rennin and its action upon casein. VII. Splitting off of non-protein nitrogen.

ALAIS, C., MOCQUOT, G., NITSCHMANN, H., AND ZAHLER, P. *Helv. Chim. Acta, 36,* 1955-68 (1953).

Rennet curdling of milk causes an increase in NPN when 12% trichloroacetic acid is used. A specific degradation reaction is involved. Cryst. rennin acts in the same manner as com. rennet. The NPN consists of more than one peptide from the α-casein only. The importance of this reaction to primary milk curdling is discussed as well as the similarity to the fibrinogen system.

(Continued on page 18)

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

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SELECTED ABSTRACTS

(Continued from page 16)

New results in the enzymology of starch and pectin.

SCHUBERT, E. *Melliand Textilber., 34,* 1067-9 (1953); *J. Sci. Food Agr., 5,* 182 (1954).

Amylo (1→6) dextrinases, the pectinases (that hydrolyze pectin, pectin esterases, and pectin glucosidases) are discussed. The analogy between starch and pectin is examd. by the respective actions of pectin glucosidases and amyloglucosidases on pectin and starch.

Temperature and rate of enzyme action.

BELEHRADEK, J. *Nature, 173,* 70-1 (1954).

Inhibition of enzymic color formation in potato by adenosine triphosphate.

MAKOWER, R. U., AND SCHWIMMER, S. *Biochim. et Biophys. Acta, 14,* 156-7 (1954).

Exts. and macerates of potato tubers, in common with those of many other plant tissues, darken as an end result of tyrosinase or polyphenoloxidase activity. The color formation is enhanced by the addn. of suitable substrates such as dihydroxyphenyl alanine (DOPA), catechol, or other phenols, and is delayed or prevented by appropriate reducing agents, Cu combining agents, and phenolic competitive inhibitors. We have now observed that ATP also has the property of retarding color formation in potatoes.

The effect of fat level of the diet on general nutrition. XI. The protective effect of varying levels of ethyl linoleate against multiple sublethal doses of x-irradiation in the rat.

CHENG, A. L. S., RYAN, M., ALFIN-SLATTER, R., AND DEUEL, H. J. *J. Nutrition, 52,* 637-43 (1954).

On the basis of the av. length of survival, and from comparison of the periods required for LD_{25}, LD_{50} and LD_{75} to be reached in male rats subjected to x-irradiation, it was demonstrated that the protective effect of ethyl linoleate became greater with increasing dosage. The optimum dosage for protection against x-irradiation injury, in male rats, probably exceeds 100 mg. per day.

Some aspects of the chemistry and biochemistry of cholesterol.

FIESER, L. F. *Science, 119,* 710-15 (1954).

A discussion of cholesterol which includes its role in the human body and the possible carcinogenicity of the compd. or of some related or derived substance. It is suggested that free cholesterol in the red blood cells may act as a detoxifying agent.

Specificity of bond fission during the acid hydrolysis of insulin.

MILLS, G. L. *Biochem. J., 56,* 230-3 (1954).

Digestion of insulin in 10.5 *N* HCl at 0° is shown to cause preferential fission of peptide bonds involving amino groups of serine and threonine residues and, to a smaller extent, of alanine, glutamic acid and aspartic acid residues.

Analytical and chromatographic studies on the Maillard reaction.

TAUFEL, K., AND IWAINSKY, H. *Biochem. Z., 323,* 299-308 (1952); *Biol. Abstr., 28,* 782, No. 7957 (1954).

The Maillard reaction was studied in the model soln. of glucose (G) and amino acids heated to 96-97°. The 2 components combined quickly producing a deep color followed by a ppt. The G concn. decreased rapidly while the total reducing power decreased slowly, indicating formation of reducible products. Chromatographically hydroxy-methylfurfurol is demonstrable. New material is produced which reacts with aniline hydrophthalate and ninhydrin. A melanoid pigment, which is reduced by 2,6-dichlorophenol-indophenol and vitamin C, is also produced.

MICROBIOLOGY

The survival of milk bacteria in Ringer's solution held for 18 hours at 3-5°.

THOMAS, S. B., DAVIES, M., AND GRIFFITHS, D. G. *Lab. Practice, 3,* 146-7 (1954).

It is recommended that rinse and swab samples of dairy equipment made with quarter-strength Ringer's soln. should be examd. within 6 hr. of sampling and that they should not be refrigerated overnight before examn.

NUTRITION

Observations on the metabolism of alcohol.

SCHROETER, L. C., AND ZUPKO, A. G. *J. Am. Pharm. Assoc., Sci. Ed., 43,* 270-7 (1954).

The effect of EtOH on the *in vitro* deposition of cholesterol and on the kidney citrate content is presented. The rate of disappearance of EtOH from the blood of rabbits is accelerated by the administration of adenosine triphosphate or fructose, but not by the administration of Chlor-Trimeton, Pro-Banthine or Dormison.

A mechanism of the vitamin-sparing effect of antibiotics.

MONSON, W. J., HARPER, A. E., WINJE, M. E., ELVEHJEM, C. A., RHODES, R. A., AND SARLES, W. B. *J. Nutrition, 52,* 627-36 (1954).

The growth of chicks fed synthetic diets contg. limiting amts. of folic acid was increased by supplementing the diets with antibiotics. Increase in growth was accompanied by the appearance of one or more coliforms in the ileum and duodenum contents that produced increased amts. of extra-cellular folic acid. It was also observed that the increased folic acid production was correlated with increased liver folic acid, but there was no change in the concn. of intestinal folic acid.

Parenteral administration of aureomycin to young calves with a note on mode of action.

RUSOFF, L. L., FUSSELL, J. M., HYDE, C. E., CROWN, R. M., AND GALL, L. S. *J. Dairy Sci., 37,* 488-97 (1954).

Parenteral administration (intramuscular injection) of 400 mg. of aureomycin (I) to young calves once weekly increased growth by 30% over controls at 16 wks. of age. I administered orally at a level of 50-90 mg. daily stimulated growth by 20%. I also caused a significant increase in height at withers. The mode of action of I in stimulating growth in the young calf is not due to its action in the rumen. It is suggested that bone metabolism may be the area in which I exerts its effect.

Interrelation of fat, carbohydrate and vitamin E in the diet of the growing rat.

VISWANATHA, T., GANDER, J. E., AND LIENER, I. E. *J. Nutrition, 52,* 613-26 (1954).

The growth-promoting properties of corn oil and butterfat for the vitamin E-depleted rat were compared using lactose or sucrose as sources of carbohydrate both in the presence and absence of supplemental vitamin E. In the absence of supplemental vitamin E and with lactose constituting the carbohydrate component of the diet, butterfat supported a rate of growth which exceeded that produced by corn oil. With the administration of vitamin E, however, no demonstrable difference between the two fats was evident on either the lactose- or sucrose-contg. rations.

Effects of a lysine deficiency upon enzyme activity in rat liver.

BOTHWELL, J. W., AND WILLIAMS, J. N. *Proc. Soc. Exptl. Biol. Med., 85,* 544-7 (1954).

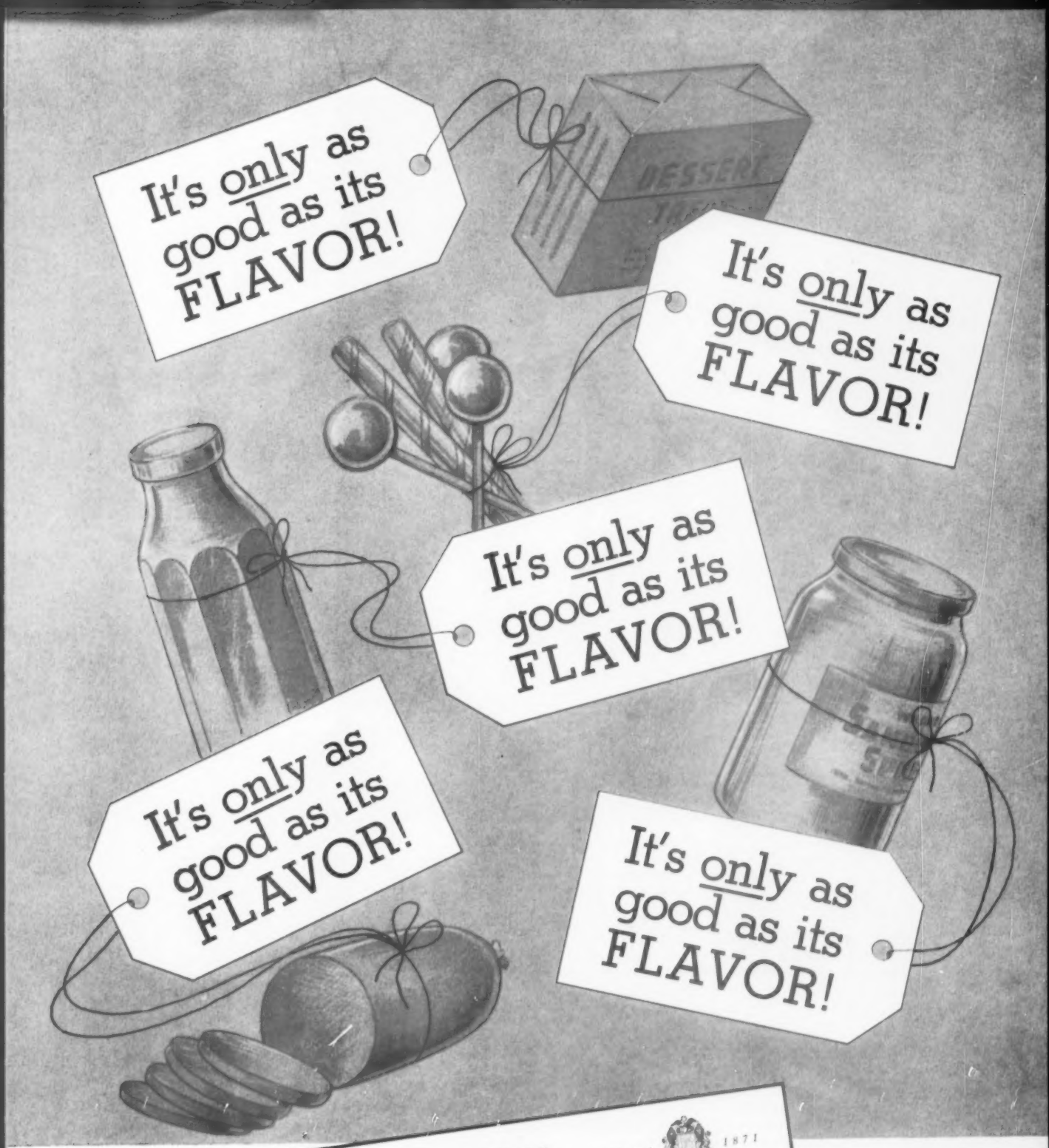
A lysine-free ration fed to weanling rats reduces the activity of liver enzymes xanthine oxidase, succinic oxidase and choline oxidase to somewhat over half of that of normal. Such deficiency has little effect on liver endogenous respiration. The deficiency produces an entirely different pattern of liver enzyme activity from that produced by a methionine or histidine deficiency.

A comparative study of human, cow, sow, and rat milk using paper chromatography.

ROBERTS, H. R., PETTINATI, J. D., AND BUCEK, W. *J. Dairy Sci., 37,* 538-45 (1954).

The analyses of human, cow, rat, and sow milk after the removal of proteins and salts have disclosed some marked differences in their respective chromatographic patterns. All, of course, contained lactose. In addn., human milk contained 11 other unidentified spots as compared to 8 for sow's milk, 6 for rat's milk, and ten for cow's milk. Glucose was found in human milk and galactose and glucose in cow's and sow's milk, whereas rat's milk contained neither galactose nor glucose.

(Continued on page 22)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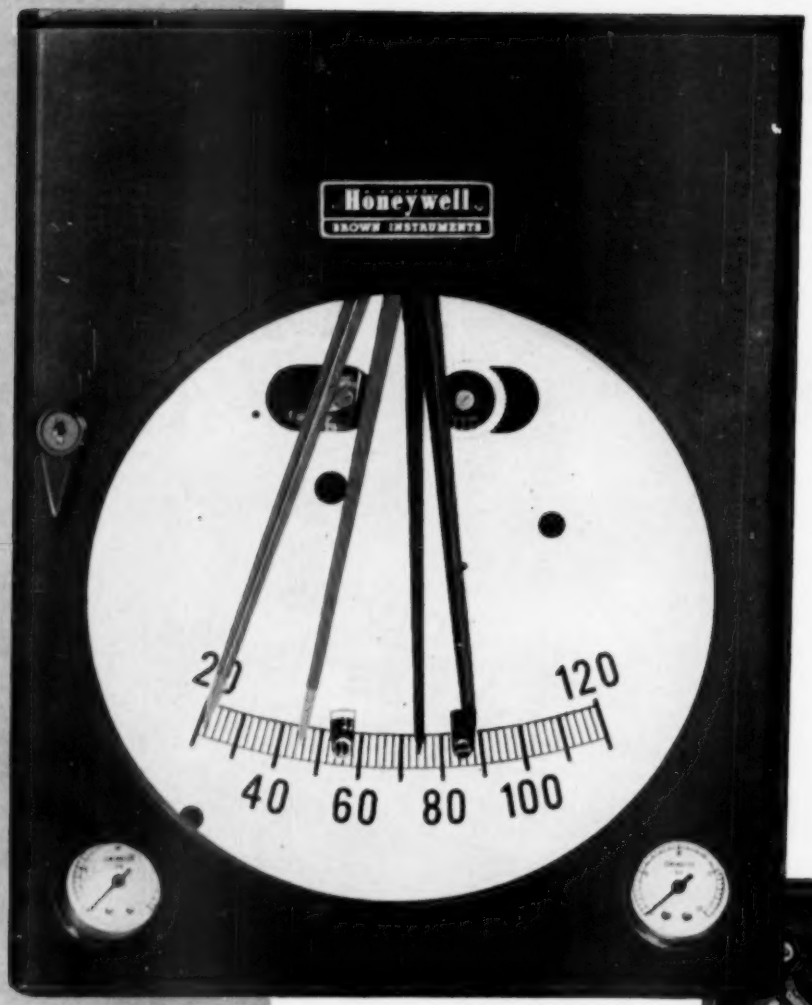

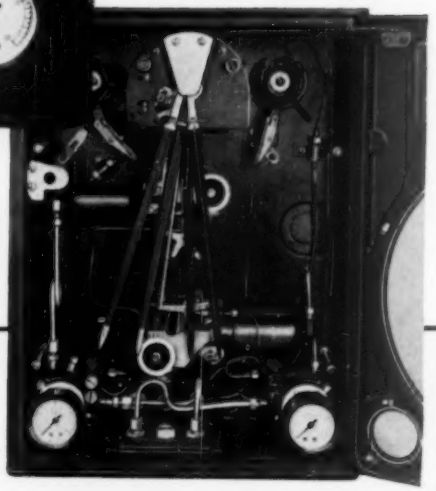

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BROWN INSTRUMENTS

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SELECTED ABSTRACTS

(Continued from page 18)

PHYSIOLOGY AND MEDICINE

Metabolic observations in insulin-resistant diabetics given intravenous fructose.

RUNYAN, J. W., AND KANTOR, N. *J. Lab. Clin. Med., 43,* 615-19 (1954).

Two cases of insulin resistance were given infusions of fructose. Elevation in the pyruvic acid levels was similar to that expected in the noninsulin-resistant diabetic and the nondiabetic. This suggests that there was no defect in the metabolic pathway of fructose to pyruvic acid in the insulin-resistant diabetics studied.

Experimental and dental caries. IV. The effect of feeding desiccated thyroid and thiouracil on dental caries in rats.

MUHLER, J. C., AND SHAFER, W. G. *Science, 119,* 687-9 (1953).

It was shown that decreased thyroid activity was related to increased caries susceptibility in the rat. This was interpreted to indicate that the activity of the thyroid is related in some manner to the incidence of dental caries in the rat.

Intravenous infusion of coconut water.

EISEMAN, B. *Arch. Surg., 68,* 167-78 (1954); *Chem. Abstr., 48,* 5441c (1954).

The H_2O of unripe coconuts was studied as a potential source of intravenous fluid for use in areas of the world where such solns. cannot be pred. It was found to be a sterile pyrogen-free fluid contg. between 2.5-5.9 g./100 cc. of fructose and glucose. In no sample was there any evidence of an *in vitro* or *in vivo* hemolysis of canine or human blood. Rabbits and dogs tolerate large amts. and show no chem., clinical, or microscopic evidence of toxicity. After acute and chronic administration, there was no evidence of antigenicity.

ENGINEERING AND PLANT EQUIPMENT

Gyratory sieving of powdery materials.

HURST, J. *Food Manuf., 29,* 187-90 (1954).

The screen surface is impelled to move in such a manner that, while not itself rotating, any point upon the mesh surface describes a circular orbit. Such a movement was brought about by attaching the screen rigidly to an out-of-balance flywheel, rotating in a horizontal plane, the whole assembly being freely suspended from its vertical axis. Applications to the bakery and chocolate industry are discussed.

Mixing.

QUILLEN, C. S. *Chem. Eng., 61,* 177-224, June, 1954.

A thorough analysis of mixing is presented including liquid, pastes, plastics, solids and continuous mixing. Included are ranges of operation of mixers, adaptability of mixers, and the action of mixing elements.

FOOD AND FOOD TECHNOLOGY

FISH AND SEAFOOD

Cause and control of the browning of heat-processed fish products.

TARR, H. L. A., AND BISSETT, H. M. *Fisheries Res. Board Can., Bull. No. 98; Progr. Repts. Pacific Coast Stas.,* 3-5, April, 1954.

The present report deals with further work on the formation of ribose in fish muscle and with a method of removing it experimentally in order to prevent browning.

GELATIN

Recent advances in gelatin research.

WARD, A. G. *Chemistry & Industry,* 502-5 (1954).

A 1st approach to the explanation of the properties of gelatin is now given by the concept of 3 structural features of which account must be taken: (1) iso-elec. pt.; (2) mol. wt. distribution; and (3) the unknown gel forming factor.

LEGISLATION

Flavoring and coloring added to coffee.

Food, Drug Cosmetic Law Repts., 140, 3, May 3, 1954.

Coffee to which coloring and flavoring have been added to improve its taste is not adulterated if the additive is not used to supplement a given wt. in order to produce a greater no. of cups of the brewed product but is a sort of catalyst which causes the coffee bean to exude its natural flavor in greater vol. Since such coffee is thereby improved, there is no concealed inferiority.

Permits for foods which do not conform to standards.

Food, Drug Cosmetic Law Repts., 140, 1, May 13, 1954.

The Statement of Policy regarding permits for the introduction into interstate commerce of "a food contg. an ingredient not permitted by an applicable standard" is revised to concern "a food (which) does not conform to an applicable standard." Permits to introduce non-conforming foods into interstate commerce may be obtained.

Labeling of drugs containing wintergreen oil.

Food, Drug Cosmetic Law Repts., 138, 2, April 16, 1954.

Drug prepns. contg. more than 5% wintergreen oil will be regarded as misbranded unless the labeling warns that use other than as directed may be dangerous and prepn. should be kept out of reach of children to prevent accidental poisoning.

ODORS

Odor and chemical constitution.

WRIGHT, R. H. *Nature, 173,* 831 (1954).

Wright believes Dyson's hypothesis correlating odor specificity with mol. vibration is correct in principle, but wrong in the frequency range suggested. The Raman frequency range below 1,000 $cm.^{-1}$ is stated to be the important range.

SUGARS

Fermentability of maltose.

BLAIR, M. G. *Arch. Biochem. et Biophys., 48,* 17-22 (1954).

Pure maltose is fermented incompletely, but maltose with at least 1% D-glucose initially present can be fermented to the same extent as D-glucose. The still residues from incompletely fermented maltose solns. can be further fermented to produce the expected quantity of alc., but their reducing power is lower than that calcd. for the unfermented maltose.

PHYSICAL RESEARCH

The determination of particle size.

CORCORAN, N. *Paint Manuf., 23,* 366-8 (1953); *Chem. Abstr., 48,* 4227e (1954).

Included in the discussion are: the theory of the detn. of particle size, the effect of shape, equiv. diam., and a discussion of elutriation and sedimentation methods of particle size detn.

RADIOCHEMICAL RESEARCH

Radioactive versene.

Atomic Energy Newsletter, 11, 3, May 4, 1954.

The chelating agent, versene, is being made available for research purposes in a radioactive form.

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

1954	
October 1-6	American Bakers' Association, Chicago, Illinois
October 8-12	American Meat Institute, Annual Meeting and Exposition, Palmer House, Chicago, Illinois
October 12-15	National Chemical Exposition, Coliseum, Chicago, Illinois
October 11-16	Dairy Industries Supply Association, Atlantic City, New Jersey
November 15-18	International Soft Drink Industry Exposition, Convention Hall, Philadelphia, Pennsylvania
June 12-16, 1955	**Institute of Food Technologists, Hotel Deshler, Columbus, Ohio**

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

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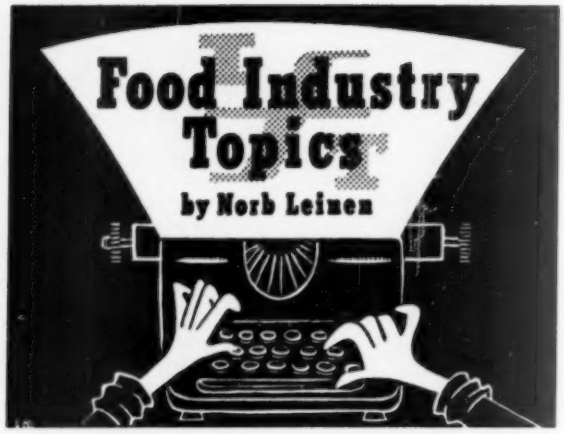

. . . *in the public interest*

Applications will be accepted until October 15, 1954, for **Fulbright Awards** for university lecturing or for research at the post-doctoral level during the academic year 1955-56 in the following countries: Austria, Belgium and Luxembourg; Ceylon; Denmark; Egypt; Finland; France; Germany; Greece; Iraq; Italy; Japan; Netherlands; Norway; Pakistan; Sweden; United Kingdom and Colonial Dependencies. For application forms and additional information write Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D. C.

◆ ◆ ◆

Approximately two-thirds of an 11 per cent decline in farm food prices since 1951 has been passed on to consumers in the form of **lower retail food prices,** according to Mr. Paul S. Willis, president of Grocery Manufacturers of America, Inc., New York City. Sharply increased costs of labor, transportation, and taxes prevented the decline in retail prices from fully equaling the decline in farm prices, he said. These three factors also account for about 85 per cent of the increase in spread between farm and retail prices in recent years. In a letter to Cong. Clifford R. Hope, chairman of the House Committee on Agriculture, the food industry executive said that USDA figures do not support a recent Committee report that farm price declines have not been reflected in retail food prices which, the report contended, are right at their post-war peak. Mr. Willis added that GMA studies thoroughly agreed with a major conclusion noted by Mr. Hope in releasing the Committee's report. That is, that the increase in cost of food after it leaves the farm is due largely to consumer demand for better processing, more convenient and attractive packaging, plus increased labor costs in processing, transportation, and marketing. To this, he said, "We would add one other major factor—taxes."

◆ ◆ ◆

A four-year $2,400 scholarship program has been established at Illinois Institute of Technology, Chicago, by the Corn Products Refining Company, Argo, Ill., to help relieve the shortage of science and engineering graduates. The firm will award a scholarship annually to an entering freshman. The scholarship will provide $600 in tuition annually for four years. For the first year, Corn Products is presenting a scholarship to one student in each of the undergraduate classes at Illinois Tech.

◆ ◆ ◆

A special course in the **basic principles of food and drug plant sanitation and sanitary control** will be offered during 1954-55 by the Evening College Department of Biological Sciences, Drexel Institute of Technology, Philadelphia. The courses are designed to meet the needs of the food and drug industry in providing qualified workers for quality control jobs in plant operation. It is particularly directed to production workers, laboratory technicians, administrative and supervisory officers.

(Continued on page 30 following technical papers)

Effect of Pulp Quantity on Chemical and Physical Properties of Citrus Juices and Concentrates[a]

A. H. ROUSE, C. D. ATKINS, AND R. L. HUGGART
Florida Citrus Experiment Station, Lake Alfred, Florida

(Manuscript received May 29, 1954)

The effect of pulp quantity, ranging from 2 to 26% by volume, on water-insoluble solids, pectinesterase activity, pectic substances, clarification, and gelation in citrus juices and frozen concentrates is presented in tabular and graphic form for Pineapple and Valencia oranges and Duncan grapefruit. The chemical and physical changes were measured prior to concentration, after processing, and after storage of the concentrate at 80° F. (26.7° C.) for 24 hours.

An essential factor in ascertaining a U. S. standard grade for canned citrus juices, frozen citrus concentrates, and canned concentrated citrus juices is the absence of defects. This factor amounts to 40 grade points out of a total score of 100. This paper is concerned with free and suspended pulp, which if excessive is termed a physical defect by the Production and Marketing Administration, U. S. Department of Agriculture.

Frozen concentrated grapefruit juice *(9a)*, frozen concentrated blended grapefruit juice and orange juice *(9b)*, and canned concentrated grapefruit juice *(9c)* may not contain more than 10%, 12%, and 10%, respectively, of free and suspended pulp when reconstituted or rehydrated in order to make U. S. grade A or U. S. Fancy. Canned grapefruit juice *(9d)* and canned blended grapefruit juice and orange juice *(9e)* may not contain more than 10% and 12%, respectively, of free and suspended pulp to be graded A or Fancy. However, frozen concentrated orange juice *(9f)* and canned orange juice *(9g)* to be graded A or Fancy must be practically free from defects such as excessive juice cells, particles of membrane, core, peel, and seeds.

Olsen, Huggart, and Asbell *(7)* extracted the juice from Pineapple oranges and Duncan grapefruit at varying press pressures and presented data to show the effect of coarse pulp in the resulting 42° Brix frozen concentrates on gelation and clarification. These authors pointed out that the variation in the degree of gelation may be caused by two factors; water-insoluble solids in the pulp and soluble pectic substances in the pulp and juice when high extractor or finisher pressures are used.

The purpose of this investigation is to present information on the relationship of pulp, ranging from 2 to 26% in Pineapple and Valencia orange juices and Duncan grapefruit juices, to water-insoluble solids, to pectinesterase activity, to pectic substances, and to gelation and clarification before and after processing the 42° Brix frozen concentrates and after storage of the concentrates at 80° F. (26.7° C.) for 24 hr. This report also contains data concerned with the quantitative amount of pectin in the initial 42° Brix concentrates which resulted in various degrees of gelation when the concentrates were subjected to a temperature of 80° F. (26.7° C.) for 24 hr.

[a] Cooperative research by the Florida Citrus Experiment Station and Florida Citrus Commission, aided by a grant from the American Can Company. Florida Agricultural Experiment Station Journal Series, No. 273.

EXPERIMENTAL PROCEDURE

Preparation of samples. Juice, pulp, and seeds from Pineapple and Valencia oranges and Duncan grapefruit were extracted by a Citro-Mat extractor and screened on a 165-mesh shaker screen. This gave a juice having a low percentage of pulp by volume. The pulpy juice and seeds not passing through the 165-mesh screen was run through a Food Machinery, Model 35, finisher with the pressure head tightly set and equipped with a 0.030-inch screen. This produced a juice with a high pulp content. Eight packs from each fruit variety were made, containing approximately 2 to 26% pulp, by mixing proportional amounts of 165-mesh screened juice with 0.030-inch screened juice. Samples of all of these juices were frozen for future analyses and the remainder concentrated to 42° Brix, put into 6-ounce cans, vacuum sealed, and placed at −8° F. (−22.2° C.).

Methods of analyses. Only the juices prior to concentration were examined for pulp by a centrifugal method *(9a)*. Water-insoluble solids were estimated by the A.O.A.C. method *(1)*, slightly modified by the substitution of centrifugation for gravity filtration during the washing procedure. Water-insoluble solids are expressed in grams per 100 g. of total solids.

Pectinesterase activity was determined essentially by the procedure of MacDonnell, Jansen, and Lineweaver *(6)*. Pectinesterase units (PE.u.) were expressed as the milliequivalents of ester hydrolyzed per minute per gram of total solids. For easy interpretation the pectinesterase units were multiplied by 1000.

The extraction of the pectic substances, divided into 3 groups on the basis of their solubility in water, ammonium oxalate, and sodium hydroxide, followed the procedure of Atkins and Rouse *(2)* and the estimation of the pectic substances was determined by the rapid colorimetric method of Dische *(5)* as applied to citrus juices by Dietz and Rouse *(4)*. Pectic substances are expressed in percentage of total pectin determined as anhydrogalacturonic acid.

The turbidity or "cloud" in the single-strength juices and in the reconstituted juices was determined by measuring the percentage of light transmission through centrifuged samples as described by Atkins, Rouse, Huggart, Moore, and Wenzel *(3)*. The degree of clarification in the centrifuged orange juices is indicated by the percentage of light transmission as follows: 0-59% = none; 60-69% = slight; 70-84% = definite; 85-100% = extreme. In the centrifuged grapfruit juices clarification is indicated by light transmission as follows: 0-69% = none; 70-79% = slight; 80-89% = definite; 90-100% = extreme. Definite clarification would be noticeable to the consumer, whereas extreme clarification, which is the complete separation of visible solids and liquid, would cause consumer complaints.

Initial concentrates and those stored 24 hr. at 80° F. (26.7° C.) were examined for gelation *(7, 8)*. Degree of gelation is indicated as follows: 0 = none; 1 = questionable or very slight; 2 = slight; 3 = semi-gel; 4 = solid gel. Semi-gels or solid gels found in frozen concentrates would cause consumer complaints.

EXPERIMENTAL RESULTS AND DISCUSSION

Pineapple orange juices, pH 3.8, varied in total solids from 11.9 to 12.4%, whereas the content of pulp ranged

from 4 to 26%. Valencia orange juices, with pH 4.0 and dry solids from 12.8 to 13.0%, ranged in pulp from 3 to 22%. Total solids of Duncan grapefruit juices, pH 3.4, were from 10.3 to 10.9%, while the pulp varied from 2 to 23%. Total solids in the 42° Brix concentrates made from the 24 packs showed a variation from 40.6 to 42.9%. Pulp determinations were made only on the single-strength juices, and not on the reconstituted concentrates.

Water-insoluble solids. Data presented in Table 1 show that the water-insoluble solids in the 3 sets of citrus juices increased as the percentage of pulp by volume increased. This relationship is presented graphically on wet basis in Figure 1 for single-strength juices prior to concentration. Juice from seedy varieties of citrus, such as Pineapple orange and Duncan grapefruit, always contained higher water-insoluble solids than Valencia orange juice with like percentages of pulp. During processing, water-insoluble solids, when expressed on total solids basis, increased only in those concentrates made from the single-strength juices of seedy citrus varieties in which the pulp level was 10% or greater. These increases in water-insoluble solids only occurred at or above pulp levels of 10 and 17%, respectively, for Pineapple orange and Duncan grapefruit concentrates. All of the 24 samples of frozen concentrates stored for 24 hr. at 80° F. (26.7° C.) showed definite increases in the water-insoluble solids. For example, the changes in water-insoluble solids during processing of Pineapple and Valencia orange and Duncan grapefruit juices and during storage of the 42° Brix frozen concentrates resulted in an overall increase of 89.0, 83.7, and 42.2% when the percentages of pulp were 13, 12 and 12%, respectively. These increases are due to formation of insoluble polyvalent pectinates and pectates as indicated under pectic substances.

TABLE 1
Relationship of pulp to water-insoluble solids in citrus juices and concentrates during processing and storage

Pulp by volume %	Water-insoluble solids-g./100 g. total solids		
	Single-strength juice	42° Brix concentrate	
		Initial	Stored 24 hr. 80° F. (26.7° C.)
Pineapple Orange			
4.0	0.61	0.60	0.89
7.0	1.14	1.22	2.09
10.0	1.52	2.30	2.86
13.0	1.81	2.49	3.43
16.0	2.17	2.98	3.70
19.0	2.65	3.67	4.52
22.0	3.03	4.08	5.09
26.0	3.29	4.79	5.46
Valencia Orange			
3.0	0.62	0.29	0.71
6.0	0.90	0.96	1.31
8.5	1.16	1.16	2.26
12.0	1.36	1.25	2.50
14.0	1.60	1.38	2.68
17.0	1.93	1.70	3.16
20.0	2.10	2.03	3.92
22.0	2.43	2.38	4.52
Duncan Grapefruit			
2.8	0.52	0.20	0.55
6.0	1.03	0.77	1.11
8.5	1.57	1.18	1.57
12.0	1.88	1.63	2.67
14.5	2.36	2.08	3.14
17.0	2.64	2.82	3.73
20.0	3.08	3.50	4.51
23.0	3.55	4.27	5.02

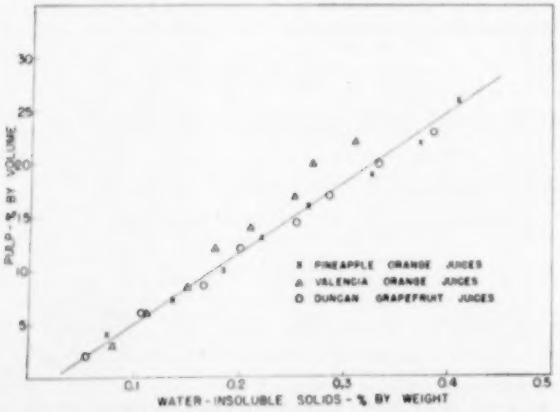
PULP - % BY VOLUME
WATER - INSOLUBLE SOLIDS - % BY WEIGHT
PINEAPPLE ORANGE JUICES
VALENCIA ORANGE JUICES
DUNCAN GRAPEFRUIT JUICES

Figure 1. Relationship of pulp to water-insoluble solids in citrus juices.

Pectinesterase activity. Pectinesterase is associated with the solid particles in citrus juices *(6)* and as the percentage of pulp is increased in single-strength juices the enzyme activity increases proportionally as shown graphically in Figure 2. Pineapple orange juice, 13% pulp, Valencia orange juice, 12% pulp, and Duncan grapefruit juice, 12% pulp, had activities of 58.6, 37.4, and 29.5, respectively. After processing, the 42° Brix citrus concentrates in the order named above had activities of 56.1, 38.5, and 17.5, whereas after storage the activities had decreased to 49.7, 34.2, and 6.4. Data graphically shown in Figure 2 indicate a definite decrease in pectinesterase after 24 hr. storage at 80° F. (26.7° C.) for all the concentrates. There was also a significant lowering of activity during processing Duncan grapefruit juices which was not in evidence when processing orange juices. Since the pH of the grapefruit juice, pH 3.4, was lower than that of the orange juices, pH 3.8 and 4.0, this loss of activity during concentration of the grapefruit juice indicated the sensitiveness of pectinesterase to the pH of the juice.

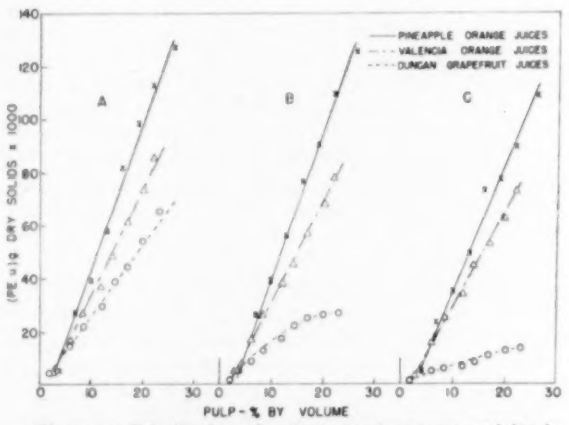

Figure 2. Relationship of pulp to pectinesterase activity in (A) single-strength juices, (B) 42° Brix concentrates, and (C) 42° Brix concentrates stored for 24 hr. at 80° F. (26.7° C.).

Pectic substances. Water-soluble, ammonium oxalate-soluble, and sodium hydroxide-soluble fractions,

expressed as percentage of total pectin for single-strength juices, for initial 42° Brix concentrates, and for 42° Brix concentrates after storage are presented in Table 2. Sodium hydroxide-soluble pectin represents protopectin, the precursor of pectin, and in single-strength juices a high quantity of this pectic substance indicates a high pulp. By increasing the content of pulp in Pineapple orange juices from 4 to 26%, in Valencia orange juices from 3 to 22%, and in Duncan grapefruit juices from 2 to 23%, total pectin was increased in each set of juices 9, 7, and 8 folds, respectively.

Data in Table 2 indicate that no hydrolysis of protopectin to water-soluble pectin had occurred during processing or storage of the Pineapple and Valencia orange concentrates. However, Duncan grapefruit concentrates stored for 24 hr. at 80° F. (26.7° C.) did show a decrease in the sodium hydroxide-soluble pectin. This indicates that some hydrolysis of protopectin is possible at pH 3.4 under these storage conditions.

Data in Table 2 show that the water-soluble pectin in single-strength juices decreased and the sodium hydroxide-soluble increased with increased pulp percentages. The trend was for oxalate-soluble pectin to increase in the 42° Brix concentrate during processing at the expense of the water-soluble pectin. Storage of the frozen concentrates for 24 hr. at 80° F. (26.7° C.) resulted in a high percentage of water-soluble pectin being converted to oxalate-soluble pectin. For example, the water-soluble pectins in the initial concentrates of Valencia orange and Duncan grapefruit, which contained 12% pulp, decreased during storage from 21.9% and 20.3% to 12.4% and 8.0%, respectively, whereas the oxalate-soluble pectins increased from 32.4% and 41.6% to 43.3% and 64.5%, respectively. This formation of insoluble polyvalent pectinates and pectates, which are ammonium oxalate-soluble, resulted in higher water-insoluble solids as shown by data in Table 1.

Clarification and gelation. Data obtained to show the relationship of pulp to the degree of clarification and gelation in citrus juices and concentrates during processing and after storage are presented in Table 3. No significant change in clarification was found initially in the Pineapple and Valencia orange concentrates or in the Duncan grapefruit concentrates made from juices with pulp levels at or below 19.0, 22.0, and 8.5%, respectively. It is of interest to note that during the concentration of Pineapple orange juices with 13% pulp or less, the cloud of the reconstituted juices was slightly improved. After storage the orange concentrates showed significant clarification at or above 6% pulp levels, whereas the grapefruit concentrate showed extreme clarification even at a 2% pulp level. Definite or extreme clarification was evident in 22 of the 24 stored samples.

Gel formation was not significant in any of the initial concentrates, but after storage of the concentrated Pineapple, Valencia, and Duncan juices a significant degree of gelation occurred at or above 13.0, 20.0, and 8.5% pulp, respectively. Semi- or solid gels were formed in 13 samples in which the pulp levels were 8.5% or greater. With increased percentages of pulp, the degree of gelation became greater, this tendency being more marked in the concentrates made from the seedy varieties than in those obtained from Valencia oranges.

Data assembled in Table 4 present tentative limits of combined water- and oxalate-soluble pectin in the initial 42° Brix concentrate necessary to form various degrees of gelation when the concentrate is stored at 80° F. (26.7° C.) for 24 hr. (Table 3). When pectin concentration in the 42° Brix Duncan grapefruit concentrates

TABLE 2

Relationship of pulp to total pectic substances in citrus juices and concentrates during processing and storage

Pulp by volume %	Percentage of total pectin								
	Single-strength juice			42° Brix concentrate					
				Initial			Stored 24 hr. at 80° F. (26.7° C.)		
	H_2O soluble	$(NH_4)_2C_2O_4$ soluble	NaOH soluble	H_2O soluble	$(NH_4)_2C_2O_4$ soluble	NaOH soluble	H_2O soluble	$(NH_4)_2C_2O_4$ soluble	NaOH soluble
Pineapple Orange									
4.0	50.0	33.3	16.7	23.0	58.6	18.4	15.6	65.4	19.0
7.0	36.1	27.8	36.1	19.2	46.2	34.6	7.8	58.7	33.5
10.0	31.9	29.8	38.3	10.3	51.9	37.8	6.6	57.9	35.5
13.0	33.0	27.2	39.8	7.7	53.3	39.0	6.0	55.9	38.1
16.0	31.5	25.2	43.3	11.2	47.1	41.7	5.4	54.2	40.4
19.0	28.6	28.1	43.3	8.2	49.5	42.3	5.0	54.6	40.4
22.0	28.6	31.8	39.6	8.1	47.7	44.2	5.0	51.8	43.2
26.0	28.4	28.8	42.8	8.8	45.9	45.3	4.1	53.8	42.1
Valencia Orange									
3.0	46.3	34.5	19.2	47.7	34.1	18.2	48.1	33.5	18.4
6.0	37.0	26.0	37.0	39.7	24.0	36.3	18.9	45.1	36.0
8.5	33.8	24.6	41.6	25.9	31.4	42.7	16.2	44.2	39.6
12.0	29.1	25.3	45.6	21.9	32.4	45.7	12.4	43.3	44.3
14.0	25.4	23.0	51.6	19.2	31.4	49.4	8.6	42.8	48.6
17.0	24.8	23.4	51.8	18.6	30.3	51.1	7.5	42.1	50.4
20.0	23.5	23.5	53.0	18.7	29.1	52.2	5.9	41.4	52.7
22.0	22.1	23.1	54.8	17.5	29.0	53.5	5.9	40.3	53.8
Duncan Grapefruit									
2.0	81.6	11.1	7.3	79.9	12.1	8.0	28.6	63.6	7.8
6.0	49.2	24.6	26.2	35.4	39.3	25.3	9.4	69.0	21.6
8.5	43.7	26.4	29.9	28.5	40.5	31.0	9.8	66.0	24.2
12.0	35.3	27.7	37.0	20.3	41.6	38.1	8.0	64.5	27.5
14.5	33.6	30.0	36.4	13.9	48.4	37.7	7.7	61.1	31.2
17.0	31.8	30.6	37.6	9.3	53.1	37.6	6.4	60.8	32.8
20.0	28.7	30.8	40.5	8.0	52.2	39.8	6.5	60.1	33.4
23.0	26.9	31.0	42.1	7.6	51.6	40.8	4.3	59.3	36.4

TABLE 3

Relationship of pulp to the degree of clarification and gelation in citrus juices and concentrates during processing and storage

Pulp by volume %	Single-strength juice	42° Brix concentrate			
		Initial		Stored 24 hr. at 80° F. (26.7° C.)	
	Clarification	Clarification	Gelation	Clarification	Gelation
Pineapple Orange					
4.0	65—slight	53—none	0—none	62—slight	0—none
7.0	65—slight	50—none	0—none	94—extreme	1—very slight
10.0	64—slight	53—none	1—very slight	97—extreme	2—slight
13.0	63—slight	50—none	1—very slight	94—extreme	3—semi-gel
16.0	63—slight	62—slight	1—very slight	94—extreme	3—semi-gel
19.0	63—slight	61—slight	2—slight	93—extreme	3—semi-gel
22.0	62—slight	71—definite	2—slight	96—extreme	3—semi-gel
26.0	61—slight	70—definite	2—slight	96—extreme	3—semi-gel
Valencia Orange					
3.0	58—none	56—none	0—none	67—slight	0—none
6.0	56—none	55—none	0—none	83—definite	0—none
8.5	55—none	57—none	0—none	90—extreme	1—very slight
12.0	56—none	56—none	0—none	92—extreme	2—slight
14.0	56—none	57—none	0—none	93—extreme	2—slight
17.0	55—none	54—none	0—none	93—extreme	2—slight
20.0	57—none	53—none	0—none	91—extreme	3—semi-gel
22.0	53—none	53—none	0—none	90—extreme	3—semi-gel
Duncan Grapefruit					
2.0	67—none	62—none	0—none	94—extreme	1—very slight
6.0	67—none	63—none	0—none	96—extreme	2—slight
8.5	66—none	77—slight	1—very slight	97—extreme	3—semi-gel
12.0	65—none	83—definite	1—very slight	96—extreme	4—solid gel
14.5	65—none	89—definite	2—slight	98—extreme	4—solid gel
17.0	65—none	86—definite	2—slight	96—extreme	4—solid gel
20.0	64—none	88—definite	2—slight	96—extreme	4—solid gel
23.0	64—none	90—extreme	2—slight	95—extreme	4—solid gel

amounted to 0.3% or greater, solid gels were formed, whereas similar concentration of pectin in 42° Brix Pineapple orange concentrates resulted in semi-gels. This difference in gel firmness may be the result of several factors *(10)*, one of which is pH. Duncan grapefruit concentrate had a pH 3.4, while that of the Pineapple orange concentrate was 3.8.

TABLE 4

Tentative limits of combined water- and oxalate-soluble pectin in 42° Brix concentrate necessary to form various degrees of gelation when the concentrate is stored at 80° F. (26.7° C.) for 24 hr.

Pectin in concentrate g./100g.	Degree of gelation
<0.170	none or very slight
0.170 to 0.220	slight
0.220 to 0.280	semi-gel
>0.280	semi-gel or solid gel[1]

[1] A pH 3.4 or lower favors the formation of a solid gel.

SUMMARY

Frozen concentrates were prepared from Pineapple and Valencia oranges and from Duncan grapefruit by processing juices having a pulp content of 2 to 26% by volume. Chemical and physical changes were measured prior to concentration, after processing, and after storage of the concentrate at 80° F. (26.7° C.) for 24 hr.

Water-insoluble solids in concentrated citus juices made from two seedy varieties, Pineapple orange and Duncan grapefruit, increased during processing of the juices with pulp levels of 10 and 17% or greater, respectively. No similar increase was found in concentrates made from the relatively seedless Valencia orange. During storage, water-insoluble solids increased in all of the concentrates.

Pectinesterase activity did not diminish significantly during concentration of the juices from the two orange varieties, but the activity was lowered during processing of Duncan grapefruit juices. There was a loss of pectinesterase activity in all samples after storage.

In general, water-soluble pectin decreased and oxalate-soluble pectin increased during processing and after storage of the concentrates. Hydrolysis of protopectin occurred in Duncan grapefruit concentrates stored at elevated temperature, but it did not take place in the orange concentrates.

Clarification and gelation increased during processing of Pineapple orange and Duncan grapefruit juices as percentages of pulp became greater, while no change took place when Valencia orange juices were concentrated. After storage for 24 hr. at 80° F. (26.7° C.), extreme clarification was evident in 21 of the 24 concentrates; semi- or solid gel formation occurred in 13 of the concentrates. These studies again emphasize the importance of low temperature storage in minimizing clarification and gelation in frozen citrus concentrates of high pulp content.

Tentative limits of combined water- and oxalate-soluble pectin in frozen 42° Brix citrus concentrates necessary to form various degrees of gelation are presented.

Experimental data are presented for consideration in establishing U. S. grade standards for pulp content.

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9. U. S. Dept. Agriculture. U. S. standards for grades of canned citrus juices and concentrates. Agricultural Marketing Service, Washington, D. C.: (a) Frozen concentrated grapefruit juice, July 1950; (b) Frozen concentrated blended grapefruit juice and orange juice, June 1950; (c) Canned concentrated grapefruit juice, November 1945; (d) Canned grapefruit juice, July 1949; (e) Canned blended grapefruit juice and orange juice, July 1949; (f) Frozen concentrated orange juice, Sept. 1950; (g) Canned orange juice, July 1949.
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Germination of Spores in Meats During Cure

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It is shown that spores of Clostridium sporogenes c, obtained from soured meats, germinate exceedingly rapidly under conditions which preclude growth. The conditions studied include 60% glucose in spleen infusion broth, 8% NaCl in the same medium, and pH of 5.3, as well as higher pH values. The spores also germinate at 4.4° C. (40° F.). From these facts, it is concluded that spores of clostridia may germinate in meats in long cure, and that the vegetative cells are prepared for rapid metabolism when the temperature becomes favorable in the smokehouse, other factors permitting.

Generally, the causative agents and the factors responsible for taint, as reviewed by Mundt and Kitchen *(8)*, are also responsible for the formation of gas in country-style cured meats. They fail to explain, however, the formation of excessive amounts of gas while the meats are in the smokehouse, for they are out of cure only for 24 to 48 hours, and during a portion of this time the meat is warming to a point at which microorganisms can grow. The explanation would seem to lie either in prior germination of the spores, or in variation in ability to overcome dormancy, with different species of clostridia, or both. In this paper it is intimated that both conditions may hold true.

Although some earlier investigators cited by Wynne *(11)* indicated that the germination of spores is more exacting with respect to environmental conditions, including temperature, than is the vegetative growth of the same species, more recent investigators [Curran *(2)*, Dozier *(3)*, Erickson and Fabian *(4)*, Itano and Neill *(5)*, Knaysi *(6)*, Williams and Purnell *(10)*, and Wynne *(11)*] have reported germination under very adverse conditions which do not permit proliferation.

EXPERIMENTAL

Inasmuch as the use of meats in cure presented difficulties, germination of spores was studied in the laboratory under conditions simulating—and more strenuous than—those encountered in the curing room. Standard techniques in the production of spores on the spleen infusion medium of Mundt and Jones *(7)*, harvest, washing, suspension in saline solution, and storage, were followed. The germinating medium was spleen infusion broth containing added sodium bicarbonate, as suggested by Anderson *(1)*. NaCl and broth were sterilized in combination; glucose was sterilized in weighed quantities in flasks with dry heat at 120° C. (248° F.) for 90 minutes, and the calculated quantity of broth (w/v) was then added aseptically. The germination tubes received, successively, 0.3 ml. of 0.5% bicarbonate solution, one ml. of the spore suspension, and 8.7 ml. of the medium, and the tubes were tilted until the contents were mixed. Pyrogallic acid and alkali (20% of the required amount as the carbonate, and the balance as NaOH) were used to obtain anaerobiosis.

The change in the spore to the heat labile form, considered a reliable criterion of germination [Wynne *(11)*], was determined according to the method of Wynne and Foster *(12)*. Aliquots of the media containing the spores were diluted to avoid the possible protective effect of sugar [Sugiyama *(9)*], heated to and held at 80° C. (176° F.) for 10 minutes in water, and then plated in spleen infusion agar with added bicarbonate, in Prickett tubes. The differences between final and initial counts represent the numbers of germinated spores.

Data at 4.4° C. (40° F.) were obtained with the use of prechilled jars and equipment, with ice added to the chamber to absorb the heat of chemical reaction evolved in obtaining anaerobiosis. The tubes, which of necessity were prepared at ambient room temperature, were plunged into a 20% solution of $CaCl_2$ cooled to —12.2° C. (10° F.) for 2 minutes.

After an initial survey of a number of cultures, *Clostridium sporogenes* c, isolated from spoiled meat, was employed. It was selected initially because of its rapidity of germination, and the choice may have been unwise, for later it was impossible to obtain rate curves.

RESULTS

The data of Table I record the numbers of spores germinated, and the percent of the total, at several times to 6 hours exposure at 37° C. (98.6° F.), at pH 7.0-7.2, in broth without and with glucose in concentrations ranging to 60%. No germination was noted in saline solution, incubated and plated simultaneously, over a 24-hour period.

From this table, it is seen that germination of the spores is exceedingly rapid, in excess of 56.4% at 1.5 hours, and that virtually all spores appear to have reached a thermolabile stage within 6 hours. Concentration of glucose apparently does not interfere with the rapidity of germination, for the percentage is approximately alike in the medium without glucose and in medium containing glucose in varying quantities through 60% of the sugar. The data presented, taken from one of triplicated experiments, are the average of 6 plates at each value, and the

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TABLE 1

Percent germination of spores of Clostridium sporogenes c in spleen infusion medium without and with glucose, at pH 7.0-7.2 and at 37° C. (98.6° F.)

Percent glucose	Orig. count[1]	Germination at			
		1.5 hours		6 hours	
		Number[1]	Percent	Number[1]	Percent
0	8.0	5.9	64.1	9.1	98.7
20	8.9	5.6	62.3	8.9	98.9
30	7.8	4.9	56.4	8.5	98.7
40	8.3	5.4	61.4	8.6	98.8
50	8.0	6.1	71.0	8.5	98.7
60	7.7	5.7	70.5	8.4	94.9

[1] Times 10^6.

differences in the vertical columns at 6 hours were not significant, as determined by the t test.[b]

Table 2, likewise representative of triplicated experiments, is a composite presentation designed to show that at a concentration of 8% NaCl (intermediate values are not included), at pH values between 5.3 and 8.0, and at a temperature of 4.4° C. (40° F.) germination is not prevented, nor is a material reduction noted. Germination is delayed at the lower temperature, but more than 90% of the spores in the suspension were germinated at 14 days.

TABLE 2

Effect of pH, temperature, NaCl, and glucose upon the percent of germination of spores of Clostridium sporogenes c in spleen infusion medium

Final pH	Time	Temperature	Percent germination in		
			Spleen infusion	Spleen infusion plus	
				60% glucose	8% NaCl
5.3	24 hrs.	37° C.	99	99	86
7.0	24 hrs.	37° C.	99	99	89
8.0	24 hrs.	37° C.	99	99	93
6.0	24 hrs.	4.4° C.	11	0	
7.4	24 hrs.	4.4° C.	3	10	
8.0	24 hrs.	4.4° C.	2	0	
5.3	14 days	4.4° C.	94	94	96
7.0	14 days	4.4° C.	95	94	93
8.0	14 days	4.4° C.	93	96	93

In culture, *C. sporogenes* c grows very sparingly in broth with 6% NaCl, and not at all in broth with 8% NaCl. It does not grow at pH 5.3 in medium containing 60% glucose, nor at 10° C. (50° F.), the latter determined in tubes incubated for 6 weeks.

DISCUSSION

The difference in the rapidity of germination of spores of *C. botulinum* as reported by Wynne and Foster *(13)*, and of *C. sporogenes* c, indicates that species difference in response to environment exists. In the initial phases of this current work, when a suitable test organism was sought, none of a number of cultures examined germinated as rapidly.

When the results reported in this paper are added to those previously published, it becomes apparent that the ability of spores to germinate under quite adverse conditions is a general, rather than a specific, property. Although exact limits of conditions circumscribing germination have apparently not been investigated extensively, it seems logical to conclude that any of a number of species of clostridia would germinate under conditions more extreme than those which enable growth.

From this it would follow that spores of clostridia are able to germinate in meats in cure, when the moisture content is still high and the salt content low, at temperatures ranging from 2.2° C. (36° F.) to 4.4° C. (40° F.). Subsequently, when the temperature rises and other factors for growth remain favorable, it is possible for the vegetative cell to become metabolically active. Conversely, it may also explain the inability to recover clostridia from sound cured meats, on the premise that the thermolabile organism is now sensitive to other factors as well, and dies.

[b] The authors are indebted to Dr. Robert J. Kieber of the Department of Bacteriology for assistance in calculating the data.

SUMMARY

Suspensions of spores of *Clostridium sporogenes* c, isolated from putrefying meat, germinate to a very high percentage within a very short time. Maximal germination was obtained within 6 hours in spleen infusion broth without glucose, and in broth containing glucose in concentrations ranging to 60%, at 37° C. (98.6° F.).

The same high prcentage of germination was obtained in spleen infusion medium containing 8% NaCl, in medium adjusted to pH 5.3, and in acid medium containing 60% glucose or 8% NaCl, within 24 hours. At 4.4° C. (40° F.), germination is delayed, but not prevented.

The results indicate that spores of anaerobes may germinate in meats in cure, and would serve to explain the rapid production of abundant quantities of gas in meats ineffectively cured, within the few hours such meats are in the smokehouse.

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Steam Blanching of Peas[a]

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Steam blanched peas are compared with conventional water blanched peas to determine the relative vitamin retention and the thermophilic flat sour contamination incident to each method. The effect of steam blanching on pea texture and on quality grading is described. The possibility of eliminating the viny or raw off-flavors of steam blanched peas is explored. Pre-washing peas in a suitable detergent solution is shown to provide effective control of off-flavors.

In preparing peas for canning, blanching in hot water has been a standard procedure since the beginning of the industry. Except for mechanization and general improvements in equipment, it is still a universal practice. Bacteriological surveys over a period of many years have shown repeatedly that conventional hot water blanchers are a constant source of thermophilic flat sour contamination, but any program of sanitation has been hampered by the inherent limitations in design of hot water blanching equipment. Such equipment is virtually impossible to clean adequately. Progress has been made, and in some instances satisfactory operations accomplished through extreme precautions and practices, but, in general, the over-all industry conclusion is that the present conventional hot water blancher still accumulates a high level of flat sour organism contamination.

The procurement of canned peas for the Armed Forces during World War II stimulated efforts to reduce flat sour contamination. Canned foods shipped to the tropics encountered ideal incubation temperatures for the growth of any viable thermophilic organisms. Because of the hazard of flat sour spoilage, a great desire for thermophile-free canned foods developed.

Although hot water blanching is the more common method used by processors of frozen peas, steam blanching—an alternate method—has been used with apparently good results. Despite the considerable variation in design of existing steam blanching equipment, it is believed that this equipment could be modified to incorporate features enabling thorough cleansing and sanitary up-keep more readily than present designs permit.

Many attempts have been made to steam blanch peas for canning, but product quality limitations have discouraged this practice. Observers have reported that strong, raw or viny-type flavors have resulted from blanching peas in steam. The degree of off-flavor has varied from slight to distinct, but it has been concluded that any off-flavor is objectionable.

As a result of the National Canners Association—Can Manufacturers Institute Nutrition Program of extensive studies on the nutrient composition of canned foods, investigations were directed toward greater preservation of nutrients during canning operations. In particular, the blanching operation used for vegetables was proposed for thorough investigation, the objective being to minimize the sacrifices of water-soluble vitamins and minerals during this operation. During the 1947 canning season, the effect of varying both time and temperature in the conventional water blanching of peas was studied. It was observed from the work reported by Heberlein *et al. (2)* and Feaster *et al. (1)* that a short time, high temperature blanch (e.g. 3½ minutes at 205° F.) gave the best retention of thiamine, niacin, and ascorbic acid with both Sweet and Alaska peas. It was concluded that extraction losses of water-soluble nutrients would be reduced by the incorporation of steam blanching in many vegetable canning operations. This finding, together with other expected advantages of steam blanching, provided stimuli for the investigations reported herein.

An over-all analysis of the blanching operation shows that blanching accomplishes two things, opposite in character: (a) the *desirable* actions of enzyme inactivation and of washing, which removes dirt, bacteria, and entrapped air and (b) simultaneously, the *undesirable* action of leaching out a portion of the essential nutrients in the natural product. Consideration of this problem led to the view that the action of blanching might be better accomplished in two steps: one step to perform the function of washing, and the other the removal of gases and the inactivation of enzymes. A greater retention of nutrients would thereby be effected. With the above considerations in mind, experiments on steam blanching were initiated in 1947 by the Research Division, Continental Can Company, Inc., in cooperation with the Chain Belt Company and the Green Giant Company, and continued through the 1951 season. The purposes of these studies were:

a. To determine whether the objectionable viny or raw off-flavors of steam blanched peas could be eliminated.

b. To compare the vitamin retention of steam blanched peas with conventional water blanched peas.

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[b] Now located with the Dow Chemical Company, Denver, Colorado.

c. To compare thermophilic flat sour contamination of the steam blanched peas against conventionally water blanched peas.

d. To determine the effect of steam blanching on pea texture.

e. To determine the effect of steam blanching on quality grading.

The effect of steam blanching on enzyme activity was not considered to be an important criterion since the peas were subsequently heat processed. Therefore, tests of this type were not included in this study. The effect of blanching and subsequent holding on some chemical constituents and enzyme activities in peas has been reported by the New York State Agricultural Experiment Station *(5)*.

EXPERIMENTAL PROCEDURE

The 1948 studies, conducted in a pea cannery of the Green Giant Co., involved batch processes of Alaska peas and a large seeded sweet type derived from Prince of Wales, of various tenderometer grades, which were blanched in an experimental steam blancher (design by Chain Belt Company, Milwaukee, Wisconsin) through which the peas were passed in a thin layer in an atmosphere of steam. Samples were obtained for vitamin analyses, and samples of the same lots of peas were taken from the exit end of a commercial blancher for control purposes. Preliminary tests of various methods of steam application were made to determine the optimum steam distribution.

In the experiments to determine whether the objectionable viny flavor could be removed by detergent washing, the peas were immersed in a detergent solution contained in a 50-gal. drum equipped with a heating coil and a mechanical stirrer. Various detergents, concentrations, and time intervals were employed. At the end of the washing period the peas were removed and washed with cool tap water. Duplicate control tests were performed each time, using a plain water wash at identical temperature and time values. All groups were steam blanched separately and samples were taken for vitamin analyses and flavor testing. Commercial water blanched samples of corresponding lots of peas were also taken for controls.

As a result of the information gathered during the 1948 studies, it was decided for the 1949 season to install a complete continuous pilot line alongside the regular commercial pea canning line (Figure 1). Thus it was possible to divert washed

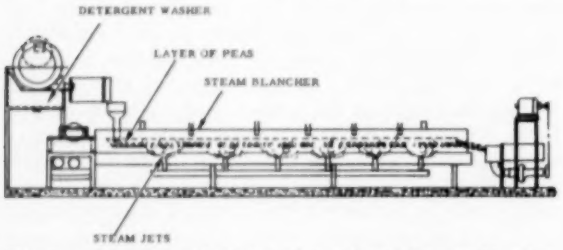

Figure 1. Diagrammatic sketch of experimental steam blancher.

peas from the commercial line through the pilot line equipment and return the flow of steam blanched peas back to the commercial line for quality separating and canning. Provisions were made to deliver a continuous flow of peas into a dewatering reel for the removal of the carrying water. The peas then entered a variable speed rotary perforated reel type immersion washer. A spiral conveyor inside of the reel provided control over the flow of peas through the washer and provisions were made to vary the time of immersion in the washing. After being discharged from the washer, the peas entered a dewatering reel equipped with water sprays to rinse off excess washing solution. They were then conveyed through the experimental steam blancher and returned to the canning line through a Scott hydraulic pump. This permitted a continuous operation, particularly desirable for the bacteriological surveys. Samples could be obtained either at the discharge end of the blancher or after canning. It was not practical to separate the sinker fraction in the continuous pilot line, but the floater fractions could be canned separately or blended with the commercial run, as desired. Control samples from the water blancher were obtained for each of the experimental runs. This same procedure was employed during the 1950 season.

DISCUSSION

Effect of steam blanching on flavor and texture. As stated, one of the chief objections to steam blanching of peas has been the viny- or grassy-like off-flavor in the final product as compared with peas conventionally water blanched. Studies in which recovered blancher water was used for brine showed the same viny flavor, indicating that the substance causing the off-flavor is either soluble in, or mechanically removed by, hot water. Apparently, the material causing the off-flavor is removed from the surface of peas during hot water blanching. Preliminary tests confirmed that a good hot water wash prior to steam blanching eliminated the off-flavor. However, this practice essentially introduces a dual blanching operation and, due to the hot water wash phase, the same potential undesirable bacteriological problems as now exist in conventional hot water blanchers remain. Therefore, it was considered highly desirable to effect a removal of the adhering off-flavor carrying material in cold water by means of a suitable detergent. Tests were conducted to compare the effectiveness of hot and cold plain water washing, hot and cold detergent washing, and hot and cold sodium hexametaphosphate washing prior to steam blanching.

In comparing the flavor of peas pre-washed for ½ minute and one minute in cold water with peas pre-washed for the same periods of time in hot water, prior to steam blanching, it was observed that the hot water wash was more effective in removing the off-flavor producing materials in the final canned product.

No significant raw, viny-, or grassy-like off-flavor remained after detergent washing for one minute at 75° F., and none of the detergents used in the wash produced any significant off-flavors in the peas. In some instances, the ½-minute detergent treatment was not as effective in the removal of the off-flavor producing materials as the one-minute detergent wash or a plain hot water wash. No significant difference was noted between Nacconal NR and Nacconol SX[e] in concentrations of 0.10% and 0.25%. Detergent washing at 160° F. appeared to be more effective in eliminating the off-flavors than detergent washing at 75° F.; however, this difference was not sufficient to justify a 160° F. wash over the same at 75° F.

Treating peas with sodium hexametaphosphate in the preliminary wash to improve skin texture also significantly reduced the viny- or grassy-like off-flavors. This treatment may be given in the conventional water blancher by adding a suitable quantity of sodium hexametaphosphate in the blanch water *(3)*. To determine whether this treatment in the pre-wash would effectively

[e] Nacconol NR and Nacconol SX are products of the National Analine Division, Allied Chemical and Dye Corp., New York, N. Y.

tenderize the skins, tests were made using various levels of sodium hexametaphosphate at both 75° F. and 160° F. for ½ and one-minute time intervals. It was found that with the same concentration, the hot water wash was more effective than the cold water wash. However, increasing the concentration of sodium hexametaphosphate in the cold water wash from 0.3 to 1.0% effectively softened the skins.

There was no significant difference between the sodium hexametaphosphate washed peas and the detergent washed peas. In view of the fact that the detergent or sodium hexametaphosphate essentially eliminated the viny off-flavors, the continuous pilot line operations for the 1950 studies were made on the basis of a one-minute, 75° F. detergent or hexametaphosphate wash prior to steam blanching.

In flavor testing the many lots of prepared samples representing the 1950 and 1951 experiments, no off-flavor was reported in any lot of steam blanched peas which had been given a one-minute detergent wash at 75° F. or a one-minute wash with sodium hexametaphosphate.

Effect of steam blanching on vitamin content. Since an objective of this investigation was to determine whether sacrifices in water soluble vitamins could be minimized, thorough investigations were made of the steam blanching process in this regard. Retentions of ascorbic acid, thiamine, riboflavin, and niacin were made on different varieties of peas of different sieve sizes and maturities as affected by variations in the steam blanching process, with corresponding commercial hot water blanched peas as the controls. The results of these investigations are shown below:

Figures 2, 3, and 4 show the ascorbic acid retention in Alaska Peas, Sieve sizes 1 through 5. Peas steam blanched for 1, 2, and 3 minutes are compared with peas commercially blanched 5 minutes at 205° F. as the controls. Figure 5 shows ascorbic acid retention studies on a number of samples of Sweet peas of the large seeded type. In these comparisons, the trend for greater ascorbic acid retention by steam blanching is clearly significant.

Since the detergent wash was initiated into the steam blanching procedure to separate the washing from the blanching *per se*, it was thought desirable to test the specific effect of a separate detergent wash on vitamin and mineral retention. Consequently, lots of peas were steam blanched, with and without detergent washing, using different concentrations of detergents, and varying time and temperature. Table 1 shows that a 0.25% Nacconol wash preceding the steam blanch had no deleterious effects on ascorbic acid content. As indicated in Figure 5, when the temperature of the detergent wash was increased to 185° F. and the length of washing time extended to one minute, there was a trend

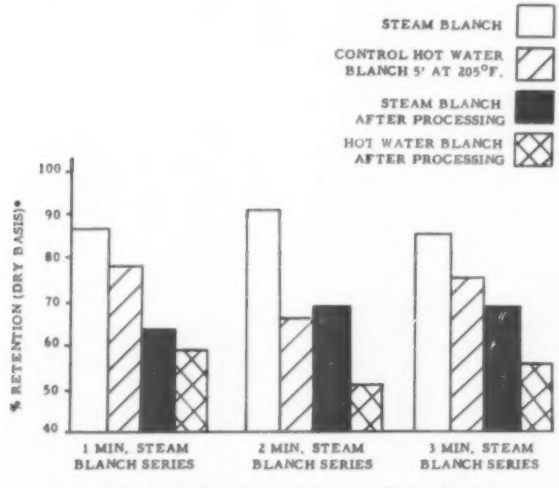

Figure 2. Effect of varying time of blanch on ascorbic acid retention in Alaska peas, sieve sizes 1 and 2, tenderometer grade 95 and under.

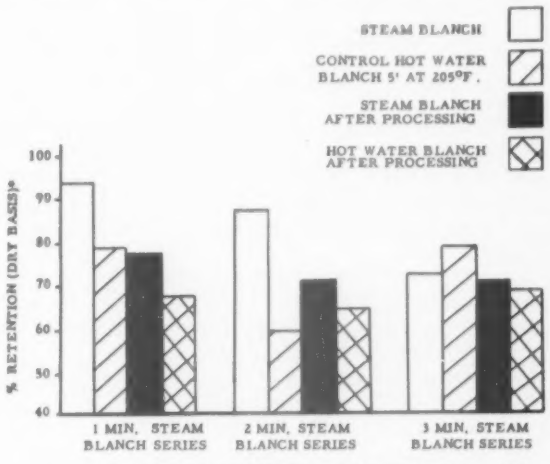

Figure 3. Effect of varying time of blanch on ascorbic acid retention in Alaska peas, sieve size 3, tenderometer grade 95 and under.

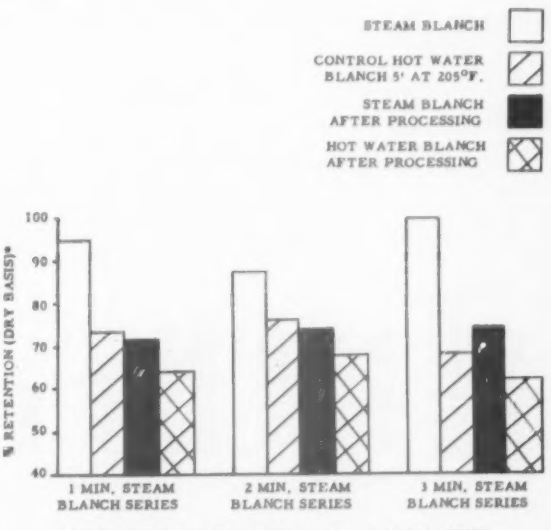

Figure 4. Effect of varying time of blanch on ascorbic acid retention in Alaska peas, sieve sizes 4 and 5, tenderometer grade 95 and under.

TABLE 1
Relation of ascorbic acid retention to presence or absence of pre-washing operation

Alaska peas[1] Sieve size	Experimental conditions	Ascorbic acid % retention
1 and 2	Washed—0.25% Nacconol 30 sec. at 75° F.	
	Blanched 2 min. at 212° F.	90
	Processed	74
1 and 2	Washed—0.25% Nacconol 30 sec. at 160° F.	
	Blanched 2 min. at 212° F.	89
	Processed	68
1 and 2	Washed—0.25% Nacconol 1 min. at 75° F.	
	Blanched 2 min. at 212° F.	85
	Processed	66
1 and 2	Washed—0.25% Nacconol 1 min. at 160° F.	
	Blanched 2 min. at 212° F.	93
	Processed	69
1 and 2	No pre-washing	
	Blanched 3 min. at 212° F.	86
	Processed	68
1 and 2	No pre-washing	
	Blanched 2 min. at 212° F.	91
	Processed	68
	Average Nacconol Washed	
	After Blanching	89
	After Processing	69

[1] Tenderometer grade—95 and under.

toward a solubility loss of ascorbic acid similar to that observed in regular hot water blanching. Since a detergent wash at 75° F. was as effective as a detergent wash at the elevated temperature, it was not thought necessary to consider higher temperature detergent washing procedures.

Ascorbic acid retentions in steam blanched and hot water blanched Alaska peas are compared in Table 2. It is interesting that the blanching *per se* showed 14.5% greater retention of ascorbic acid in the steam blanched samples than in samples hot water blanched for 5 minutes at 205° F. It was observed that upon canning and processing, the ascorbic acid retention decreased somewhat to a difference of 9.0%, which is still significant.

In Table 3 ascorbic acid retentions in steam blanched and hot water blanched Sweet peas are compared. The average difference in percentage retention of ascorbic acid in steam blanched and hot water blanched Sweet peas was 10.2% as compared with 9.9% retention in the canned product.

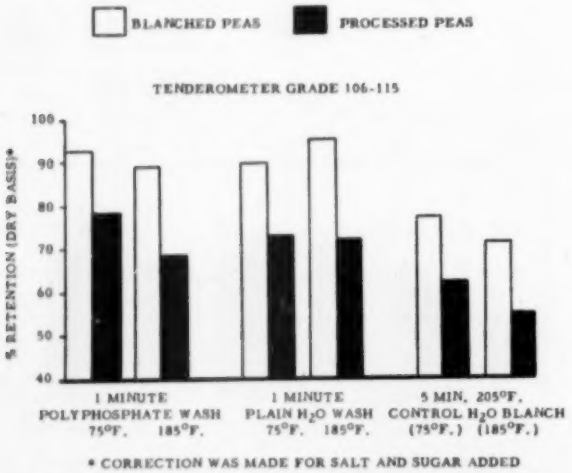

Figure 5. Effect of varying temperature of pre-wash prior to 1½-minute steam blanch on the ascorbic acid retention in Sweet peas.

Although a slight savings in thiamine content could be demonstrated for the steam blanching process, the destruction of this vitamin due to the heat process nullifies any savings in this nutrient which may have been accomplished by the improved blanching process. Figure 6 shows the results of a series of experiments on thiamine retention in Alaska peas. Similar analyses for niacin and riboflavin retention of steam and hot water blanched canned processed Sweet peas were made. However, no appreciable differences in riboflavin or

TABLE 2
Comparison of ascorbic acid retention in Alaska peas steam blanched versus hot water blanched 5 min. @ 205° F.

Sieve size[1]	Steam blanching conditions	Difference in % retention	
		Blanched	Processed
1 and 2	1 min. at 212° F.—No detergent wash	9 +	5 +
1 and 2	2 min. at 212° F.—No detergent wash	26 +	8 +
1 and 2	3 min. at 212° F.—No detergent wash	11 +	14 +
3	1 min. at 212° F.—No detergent wash	16 +	10 +
3	2 min. at 212° F.—No detergent wash	28 +	7 +
3	3 min. at 212° F.—No detergent wash	6 —	2 +
4 and 5	1 min. at 212° F.—No detergent wash	21 +	8 +
4 and 5	2 min. at 212° F.—No detergent wash	11 +	6 +
4 and 5	3 min. at 212° F.—No detergent wash	32 +	12 +
1 and 2	2 min. at 212° F.—Washed 0.25% Nacconol SX 30 sec. at 75° F.	5 +	7 +
1 and 2	2 min. at 212° F.—Washed 0.25% Nacconol SX 30 sec. at 160° F.	8 +	6 +
1 and 2	2 min. at 212° F.—Washed 0.25% Nacconol SX 1 min. at 75° F.	16 +	13 +
1 and 2	2 min. at 212° F.—Washed 0.25% Nacconol SX 1 min. at 160° F.	12 +	9 +
	Average % Retention—Steam	88.7%	70.1%
	Average % Retention—Water Control	74.2%	61.1%
	Average Difference	14.5 +	9.0 +

[1] Tenderometer grade—95 and under.

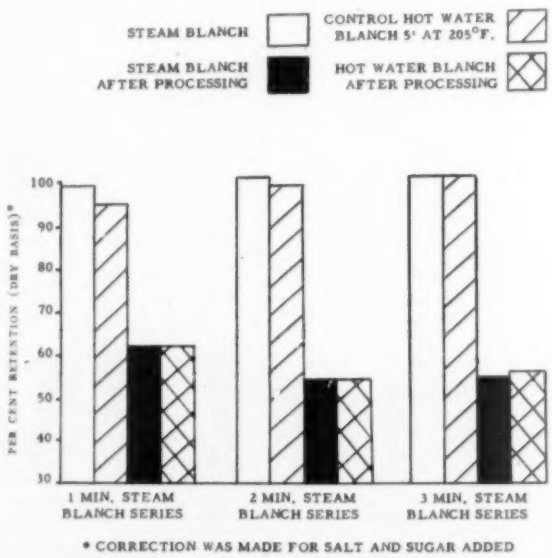

Figure 6. Effect of varying time of blanch on thiamine retention in Alaska peas, sieve size 3, tenderometer grade 95 and under.

niacin content which might be ascribed to the different blanching procedures could be detected.

It must be emphasized that the studies on nutrient preservation have been limited to vitamins. The authors have reason to believe that one of the greatest savings of nutrients in the steam blanching process may be in a saving of sugar. This highly important constituent of vegetable juice is most readily leached from all vegetable tissues during the hot water blanch. In large scale commercial canning operations, where it is desired to attain a certain level of sweetness in the final product, the savings in sugar alone for those using sugar in the brine could amount to a large sum of money. The results of work done by the Western Utilization Research Branch on steam blanching peas for freezing showed a 5% loss in total solids content, the greater portion of which undoubtedly is sugar *(4)*. With hot water blanching, depending upon the type and maturity of the peas, extraction losses of an order of 5 to 30% may be expected. The leaching of smaller amount of water solubles from the peas is one factor in explaining their higher density after steam blanching than after hot water blanching.

TABLE 3

Comparison of ascorbic acid retention in Sweet peas Steam blanched 1½ min. at 212° F. versus hot water blanched 5 min. at 205° F.

Field run tenderometer grade	Washing conditions	Difference in % retention	
		Blanched	Processed
106-115	0.1% Nacconol SX—1 min. at 75° F.	8 +	14 +
	Water wash—1 min. at 75° F.	14 +	19 +
96-105	0.25% Nacconol SX—1½ min. at 75° F.	6 +	6 +
	Water wash—1½ min. at 75° F.	11 +	12 +
96-105	0.25% Nacconol SX—1 min. at 75° F.	10 +	8 +
	0.1% Nacconol SX—1 min. at 160° F.	20 +	5 +
	0.25% Nacconol SX—1 min. at 160° F.	6 +	9 +
	Water wash—1 min. at 160° F.	15 +	4 +
Under 95	0.25% Nacconol SX—30 sec. at 160° F.	9 +	15 +
	0.25% Nacconol SX—30 sec. at 185° F.	1 +	3 +
	Water wash—1 min. at 185° F.	3 +	5 +
126-135	0.1% Nacconal SX—1 min. at 75° F.	20 +	17 +
	Water wash—1 min. at 75° F.	14 +	13 +
116-125	0.25% Nacconol SX—1 min. at 75° F.	9 +	14 +
	Water wash—1 min. at 75° F.	15 +	11 +
96-105	0.1% Santomerse No. 1—1½ min. at 75° F.	7 +	13 +
	Water wash—1½ min. at 75° F.	9 +	14 +
96-105	0.1% Duponol—1½ min. at 75° F.	4 +	2 +
	Water wash—1½ min. at 75° F.	12 +	5 +
	Average % Retention—Steam	92.0%	77.1%
	Average % Retention—Water Control	81.8%	67.2%
	Average Difference	10.2 +	9.9 +

Bacteriological evaluation of the steam blancher. As indicated, the potential danger from flat sour contamination is inherent in water blanching operations due primarily to the difficulty of maintaining the equipment in sanitary condition. In addition, the blancher water is an ideal medium for the growth of thermophilic organisms through a wide range of temperatures. Considerable attention was therefore given to a bacteriological evaluation of the steam blancher used in the pilot line operations. The studies were conducted in 1949 and 1950, and several runs over significant periods of time were made in order to duplicate conditions which would be considered normal in full scale operations. Concurrent studies were made of the thermophilic flat sour spore contamination from the cannery's conventional hot water blanchers. The contamination of the peas leaving the blancher was measured by plate counts upon the washings from the peas[d] and by a processed tube test.[e]

An attempt was made to operate the blancher continuously over a significant period of time ranging from runs of 2 to 12 hours. In the runs of 10 to 12 hours duration the steam blancher was operated for as long as cannery conditions would permit with short breaks between runs when the cannery was making changes in field grades. During these break periods the temperature in the blancher was maintained. When the cannery was not operating (noon and evening shutdowns) the steam was turned off and the blancher allowed to cool, but it was not opened or cleaned except at the end of the run. This procedure was followed in order to exaggerate the lack of sanitary care. Samples of the first peas through the equipment after a shutdown were taken for spore counts.

Table 4 summarizes the distribution of spore counts of samples of peas leaving the steam and hot water blanchers obtained during the 1949 and 1950 seasons. Note the significant difference between the spore counts of peas leaving the steam blancher and those leaving the water blancher in both the 1949 and 1950 seasons. Of the samples taken from the steam blancher during the 1949 and 1950 seasons, 69% and 85%, respectively, showed no spore count from the washings. This com-

[d] Samples of peas were taken from either the entrance or exit end of the blancher in clean, steamed 303 cans. Approximately one-half can of peas was taken as a sample. Any water present was poured from the can and 50 ml. of sterile distilled water was added from an 8 x 1 in. test tube. The can was closed with a clean cover, shaken at least 50 times, and the wash liquid poured back into the 8 x 1 in. test tube. Samples of the wash liquid were held in cold water until heated for the spore test. In order to eliminate vegetative cells and low heat resistant spores the tubes were heated in a pressure cooker for 10 minutes at 228° F. plus 4 minutes come-up from 212° F. to 228° F. After cooling, the tubes were held in cold water until samples could be plated. Three 2 ml. aliquots were plated for each sample of washings. The plates were poured with standard flat sour agar, and after cooling poured with a thin layer of 2% plain agar to prevent development of spreaders. The plates were incubated for 48 hours at 130° F. ± 10° F. and then counted.

[e] Samples of peas were taken in clean 303 cans for the processed tube test. Using a clean metal spoon, approximately 25 g. samples of peas were transferred to sterile 8 x 1 in. screw cap tubes and covered with a sterile salt-sugar brine. The tubes were processed in the pressure cooker 25 minutes at 240° F., less 0.4 of the come-up time from 212° F. to 240° F. This corresponds to an F_0 of approximately 6-7. The pressure cooker was equipped with a thermometer instead of a pressure gauge and the process carried out based on the temperature reading. After processing, the tubes were held in cold water until placed in the incubator at 130° F. ± 10° F. After 5 days' incubation the tubes were tested with B. C. P. indicator for acidity.

pares with 2% and 25% showing no spore counts in the water blanched samples for the same years.

Table 5 summarizes the results of processed tube tests on samples of peas leaving the steam and hot water blanchers during the 1949 and 1950 seasons. Again, there is a significant difference between the flat sour contamination of peas blanched in the steam blancher and those conventionally water blanched. Of the processed tube samples taken from the steam blancher during the 1949 and 1950 seasons, only 3% and 1%

TABLE 4
Summary of the distribution of spore counts of samples of peas leaving steam and hot water blanchers

Spore count per 303 can	Percent of total samples			
	1949		1950	
	Water blancher	Steam blancher	Water blancher	Steam blancher
0	2	69	25	85
1-30	2	24	35	12
31-60	2	4	10	3
61-100	16	2	20	0
101-300	36	0	10	0
300 +	41	0	0	0
Total Samples	39	89	20	34

TABLE 5
Summary of results of processed tube tests on samples of peas leaving steam and hot water blanchers

	Total number of tests	Number of tubes positive	Percent positive
Steam Blancher:			
1949	147	4	3
1950	96	1	1
Hot Water Blancher:			
1949	153	119	78
1950	102	42	41

respectively contained flat sour spores, while 78% and 41% of the tubes from the water blancher during the same period were positive.

During the course of the bacteriological surveys, samples of peas entering the steam blancher and the water blancher were also tested for thermophilic flat sours; all were found negative. It is evident, therefore, that the spores capable of withstanding the standard process were being picked up by the peas during passage through the water blancher.

In general, the spore counts obtained for peas leaving the water blanchers were considerably lower during the 1950 season than in the preceding one. The cannery was running only a few hours at a time during the 1950 season, and long shutdowns intervened which gave ample opportunity for adequate clean-up and sanitation. Most probably, this factor was responsible for the better sanitary condition of the water blanchers, the lower spore counts, and the less definite contrast in the 1950 spore counts (when compared with the 1949 counts) between peas leaving the water blanchers and peas leaving the steam blancher.

Quality grading of steam blanched peas. During the continuous pilot line operation, the steam blanched peas were run directly through the plant quality graders regularly used for separating water blanched peas. Since the same field grade peas blanched in water had a significantly higher percentage of floaters than those steam blanched, it became apparent that the steam blanched peas were not being effectually quality separated. In the pilot plant operations the sinker fraction could not be kept separated from the factory run; however, it was quite obvious that a high percentage of high quality peas which had been steam blanched were in the sinker fraction. This condition suggested that steam blanched peas had a higher specific gravity than conventionally water blanched peas. A method [1] to obtain information on the comparative density of steam and water blanched peas was developed, and examples of the data obtained are given in Table 6.

TABLE 6
Density determinations of Alaska peas [2]

Sample	W_1	W_1 (corrected)	W_2	$W_1 - W_2$	D (Peas) [3]
Raw	837.52 g.	629.55 g.	751.73 g.	85.79 g.	1.0826
Water blanch, 7 min. @ 200° F.	841.62 g.	633.11 g.	754.07 g.	87.55 g.	1.0826
2 min. steam blanch	837.35 g.	642.14 g.	753.81 g.	83.54 g.	1.0920
3 min. steam blanch	842.18 g.	631.73 g.	760.15 g.	82.03 g.	1.0940
4 min. steam blanch	852.79 g.	633.99 g.	766.19 g.	86.60 g.	1.0950

[2] Tenderometer grade 116-125, Sieve size 4 and 5.
[3] $D_1 = 1.1827$; $D_2 = 0.9970$; Temperature = 77° F.

Data presented in Figure 7 show that steam blanched peas have a consistently higher specific gravity than water blanched peas. In lots of peas of tenderometer grade 95 and under, the maximum density of both steam and water blanched peas was reached at the end of one minute. The maximum density of the more mature peas of tenderometer grade 106-115 was reached at the end of 2 minutes. The curves parallel each other with the specific gravity dropping rather sharply to its lowest value at the end of 3 minutes with both water and steam blanching. After blanching for 3 minutes there was a gradual increase in density up to 5 to 6 minutes. Whether the density would have increased further is not known since the blanching time intervals were not

[1] This method was based upon the principle of weighing the peas in 2 solutions of different densities, using special pycnometers of 500 ml. capacity. In this respect, distilled water and a saturated salt brine were found to be satisfactory. Approximately 75 g. to 100 g. of peas were placed in the flask and distilled water added until practically full. All visible air bubbles were removed by means of a glass stirring rod, the flask was filled to the top, and the excess expelled through the outlet hole of the pycnometer stopper. After drying the external surface of the flask, the weight was determined and recorded. The water was then drained from the flask using a screen retainer to keep all of the peas in the flask. As rapidly as possible the flask and its contents were rinsed once with approximately 75 to 100 ml. of the salt brine, drained, and again filled with salt brine. The weighing operation was then repeated. The resultant weights of the peas in the two different solutions were substituted in the following equation and the density calculated.

$$D = \frac{W_1 - D_1 \dfrac{(W_1 - W_2)}{(D_1 - D_2)}}{C - \dfrac{(W_1 - W_2)}{(D_1 - D_2)}}$$

where: D = Density
W_1 = Weight of the peas and salt brine
W_2 = Weight of the peas and distilled water
D_1 = Density of the salt brine
D_2 = Density of the distilled water
C = Volume of the pycnometer

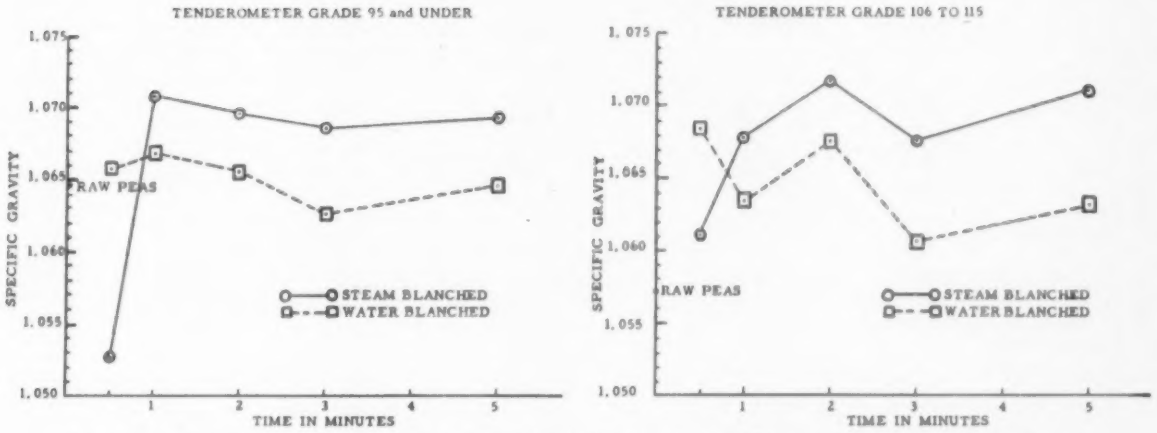

Figure 7. Comparison of specific gravity of steam blanched and water blanched ungraded, large seeded Sweet peas.

carried further. The limitations of this work impress the importance of the need for extended density studies and correlations with variations in maturity, varieties, growing conditions, and blanching procedures.

Since there was an increase in the density of steam blanched peas over water blanched peas, the next step was to compensate for this increase. The brine density was increased until approximately the same percentage of floaters was obtained from the steam blanched line as from the cannery water blanched production line. Figure 8 shows the comparative effect of increasing the brine density in the quality separators on the percentage of floaters from both steam and water blanched Sweet peas. An increase in the brine density of approximately 3 degrees for this lot of peas was necessary to obtain comparable percentages of floaters. With Alaska peas, sieve size 3, as shown in Figure 9, comparable percentages of floaters were obtained by increasing the density approximately 6 degrees. Figure 10 shows the results of another run of Alaska peas, sieve sizes 1 and 2, tenderometer grade 106-115. Here, approximately the same percentage of floaters was obtained by increasing the density of the brine by 3 degrees.

In general, increasing the brine concentration from 3 to 6 degrees salometer for Alaska and Sweet peas will provide quality separation of steam blanched peas approximately equivalent to comparable water blanched peas. There appears to be a maximum brine concentration, however, that gives similar percentages of floaters for both steam and water blanched peas, but at this maximum an appreciable number of actual sinkers are incorporated with the floaters.

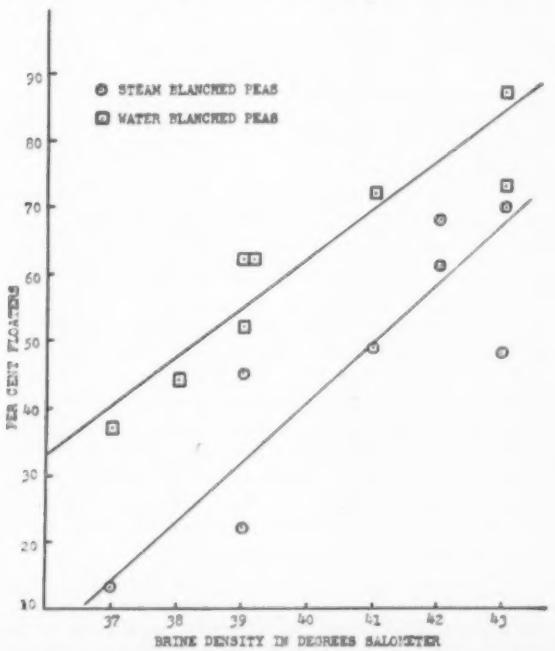

Figure 8. Effect of varying brine density in quality separators on percentage of floaters of steam and water blanched Sweet peas, tenderometer grade 106-115.

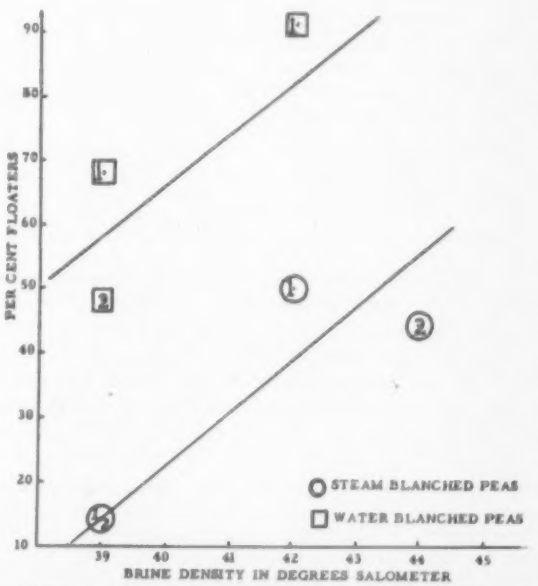

Figure 9. Effect of varying brine density in quality separators on percentage of floaters of steam and water blanched Alaska peas, sieve size 3, tenderometer grade 106-115.

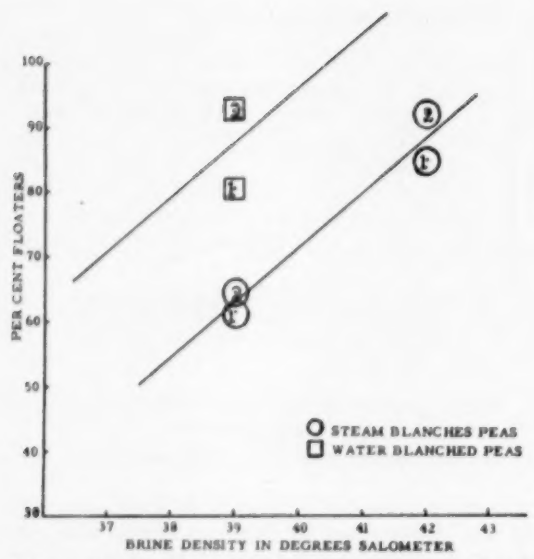

Figure 10. Effect of varying brine density in quality separators on percentage of floaters of steam and water blanched Alaska peas, sieve sizes 1 and 2, tenderometer grade 106-115.

The efficiency of the adjusted quality seaprator brine was evaluated by determining the maturity grade employed in the U. S. Standards for Grades of Canned Peas under the Production and Marketing Administration of the U. S. Department of Agriculture. Processed peas were graded in 11, 12, and 13½% salt solutions, recording the number of sinkers occurring in each instance. From these data, a maturity grade was assigned to each sample based on a maximum score of 45 points and observing the schedule of possible points in accordance with the U. S. Standards. Maturity grades were also established organoleptically, observing the schedule of possible points in accordance with the U. S. Standards. The organoleptic ratings represent an average of ratings by a panel of 4 to 6 persons, basing their judgments on chewing tests and using the following descriptive terms as a guide:

Very tender	40–45
Reasonably tender	34–39
Starchy or nearly mature	28–33
Below standard	0–27

In addition, the alcohol insoluble solids were determined as an objective measure of maturity. Table 7 gives the comparative maturity grades of 8 sets of paired samples of Sweet peas, tenderometer grade 96 to 105, after 7 months' storage. Table 8 shows maturity grades of steam and water blanched Alaska peas, tenderometer grade 106 to 115, sieve size 3. It will be noted that there is reasonable agreement between the maturity grades, as determined by salt brine separation, organoleptic grades, and the percentage of alcohol insoluble solids, of the steam and water blanched peas.

TABLE 7

Maturity grades of steam- and water-blanched Sweet peas [1] (floater fraction) after seven months' storage

	1950 Studies: 8 sets of paired samples	
	Steam blanch	Water blanch
Maturity Grade		
PMA—Average	43.25	42.3
Range	43-44	42-43
Organoleptic		
Average	37.7	36.7
Range	36.7-38.6	36.5-37.2
Percent A.I.S.		
Average	11.25	11.7
Range	10.3-12.3	10.8-12.4
Flavor Test	No off flavor	No off flavor

[1] Tenderometer grade 96-105; ungraded for size.

TABLE 8

Maturity grades of steam- and water-blanched Alaska peas [1] (floater fraction) after three months' storage

	1950 Studies: 8 sets of paired samples	
	Steam blanch	Water blanch
Maturity Grade		
PMA—Average	40.75	43.25
Range	39-43	41-45
Organoleptic		
Average	36.8	36.9
Range	36.0-38.8	35.2-39.2
Percent A.I.S.		
Average	13.8	13.7
Range	12.9-14.7	12.6-14.7
Flavor Test	No off flavor	No off flavor

[1] Tenderometer grade 106-115; sieve size 3.

SUMMARY

Steam blanching of peas has been compared with conventional hot water blanching with respect to vitamin retention, product quality, flavor, and bacteriological significance. Modification of washing procedures and quality separator brine densities were made to overcome the objectionable features of steam blanching. Results may be summarized as follows:

Ascorbic acid retention in the steam blanched peas was significantly improved over that of conventionally water blanched controls; this retention was not affected by either detergent or polyphosphate pre-washing. There were no significant differences in thiamine, riboflavin, and niacin content of the processed samples which could be ascribed to the different blanching procedures.

The viny- or grassy-like off-flavor of steam blanched peas observed in preliminary tests was confirmed in the pilot line operations. In general, pre-washing of peas in a suitable detergent solution essentially eliminated this off-flavor.

Pre-treatment of the peas with sodium hexametaphosphate effectively improved skin texture and also aided in removal of the viny flavor.

Density of steam blanched peas was greater than conventionally water blanched peas, resulting in a lower yield of floaters than water blanched peas of similar tenderometer grades. Increasing the density of the quality separator brine for steam blanched peas, to obtain equal yields of floaters as obtained from water blanching, resulted in equal product quality.

Bacteriological surveys made during continuous runs showed a significant improvement in the degree of contamination by thermophilic flat sour spores in the samples taken from the steam blancher as compared with those taken from the water blancher. The studies confirmed previous findings that hot water blanchers are a

serious source of thermophilic flat sour spore contamination.

It is recommended that more work be done to evaluate the removal of off-flavors from other varieties of Sweet peas as affected by steam blanching. Additional work should also be done on the comparative densities of steam and water-blanched peas of many varieties as related to quality separation.

Acknowledgment

The data reported by the authors are the result of an investigation conducted jointly by the Green Giant Company, the Chain Belt Company, and the Continental Can Company, Inc. Many individuals contributed considerable time and effort to the various phases of the research reported herein. Particular thanks are given to Messrs. G. K. Viall, Weld Conley, and Albert M. Olson of the Chain Belt Company under whose direction the pilot steam blancher was designed and built. Acknowledgment is also given to Mr. E. W. Eue and the management of the Green Giant Company for making possible the use of their facilities, space, product, and personnel at their Le Sueur and Montgomery canneries and their Le Sueur Laboratory.

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Factors Affecting the Color Stability of Frozen Montmorency Cherries

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(Manuscript received May 12, 1954)

The effects of (a) metal ion contamination, (b) sequestering agents, (c) antioxidants, (d) oxygen, and (e) various sugars on the color stability of Montmorency cherries frozen in small packages are reported. It is shown that significant protective action on color is obtained by phytic acid, ascorbic acid, and corn sirup. The protective action of corn sirup on color appeared to be superior to that of sucrose.

Several studies have been made of factors affecting the quality of frozen and canned cherries. Included have been: the effect of various types of sugars as related to quality and drained weight *(6, 7, 8)*; the relationship between added ascorbic acid and oxidation *(6, 7, 10)*; the effect of calcium phytate on metal induced discoloration *(3, 4)*.

A considerable volume of cherries is frozen in bulk quantity for food industry uses. Much of the review of the factors affecting the quality of frozen cherries has been in terms of bulk packed product. An increased amount of cherries is being frozen in small consumer sized packages. The stability of color of frozen cherries in small packages is highly desirable. A study was made over a two-year period to determine the magnitude of the effect of various factors on the color of Montmorency cherries frozen in small packages.

PROCEDURE

The cherries used were obtained at a commercial canning and freezing plant and were of good quality. They were processed in the commercial freezing line. The cherries were soaked, washed, inspected, stemmed, pitted and inspected again. They were immediately placed in either plain 303 x 406 tin-lined cans or in pliofilm bags. Sucrose sugar was added at a ratio of 1 part to 5 parts of cherries. Various treatments, replicated 5 times (subsequently described), were introduced at this point in each of the 2 years of study. The sealed containers were immediately placed in a freezer and blast frozen at —18° F. (—28° C.).

The factors investigated in the treatments were: (a) metal ion contamination; (b) sequestering agents; (c) antioxidants; (d) oxygen; (e) various sugars.

The study of the effect of metal contamination was conducted by the addition of cupric and ferric chloride solutions. Levels of 3 and 6 p.p.m. of copper and 5, 10 and 20 p.p.m. of iron were used. Phytic acid was used as a sequestering agent at a level of 0.1%. Antioxidants used were ascorbic acid and mixtures containing ascorbic acid and citric acid in percentages of 4-96 and 8-92, respectively, at levels of 100, 200 and 300 mg./lb. The role of oxygen was investigated by packing the cherries in the tin cans and sealing under an average vacuum of 25 inches Hg. The sugars used in the study were sucrose, inverted sucrose sirup and corn sirup. Color evaluation was made at intervals of 0, 4 and 8 months' storage at —10° F. (—23° C.).

Color was measured by means of a Hunter Color Difference Meter, which was standardized with a National Bureau of Standards plate No. 073-632-317, SKC-70. This plate has Hunter values L, 28.6; $a_L + 47.1$; and $b_L + 17.1$, which correspond to an I .C. I. notation of Y, 8.18%; x, 0.619; and y, 0.325. The samples were thawed by immersion in warm water at 130° F. (54° C.) for approximately 50 minutes. They were then held at 75° F. (24° C.). The color was determined immediately after thawing and at 3 and 6 hour intervals. The whole cherries were packed in a cylindrical cell 4.4 cm. high and 6 cm. in diameter to a depth of at least 3 cm., the color measured and reported in terms of either Hunter chroma ($\sqrt{a_L^2 + b_L^2}$) or Hunter redness (a_L/b_L). Color deterioration is indicated by a reduction in either of the two corresponding values.

The rate of tannin oxidation was determined using the method of Guadagni, Sorber and Wilbur *(5)* by blending 250 g. of frozen cherries with an equal amount of distilled water. The speed of the blender was adjusted so that the temperature of the mixture reached 81° F. (28° C.) in 15 minutes. The speed was then

reduced in order to maintain this temperature. At intervals of 15 minutes, 50 g. samples were removed and total tannin determined by the method of Rosenblatt and Paluso *(9)*. The results are reported in terms of μg. of tannin oxidized per ml. of extract during a 30 minute interval.

RESULTS

Effect of metal contamination. The effect of added cupric and ferric ion on the color of whole cherries, frozen 6 months at zero and 6 hours after thawing is illustrated in Table 1. Two different lots of cherries are represented in the data. The added iron appeared to have a greater deteriorating effect on the color of the cherries. The major portion of this change in color values apparently is due to the formation of a metal-tannin complex. The major portion of the deterioration in the iron treated samples was present at zero hours after thawing, as compared with

TABLE 1

The effect of various amounts of added cupric and ferric ions on the color of cherries stored frozen 6 months in pliofilm bags and in metal cans and subsequently thawed

Treatment	Metal cans Vacuum pack		Pliofilm bags Atmospheric pack	
	Color value (Hunter chroma)			
	Series 107		Series 5A	
	0 hours	6 hours	0 hours	6 hours
Untreated	23.7	22.9	21.2	21.1
Copper added (3 p.p.m.)	25.5	23.5	22.1	22.0
Copper added (6 p.p.m.)	24.6	21.9	22.6	20.5
Iron added (5 p.p.m.)	24.0	21.4	20.6	19.6
Iron added (10 p.p.m.)	19.6	20.1	18.8	17.6
Iron added (20 p.p.m.)	18.3	18.6	16.6	16.2

that which developed within 6 hours. If enzyme activity were the principal cause of the color deterioration, it would have become more apparent in the 6 hour interval.

The data presented in Figure 1 show the rate of oxidation of tannin in the presence of increasing amounts of added ferric ion. The rate decreases with an increase of ferric ion. While added iron suppresses the rate of enzymatic oxidation of tannin, this protection of the color is not as significant as is the deleterious effect of the formation of a metal-tannin complex. The discoloration of maraschino cherries by the formation of an iron-tannin complex has been established by Butland *(1)*.

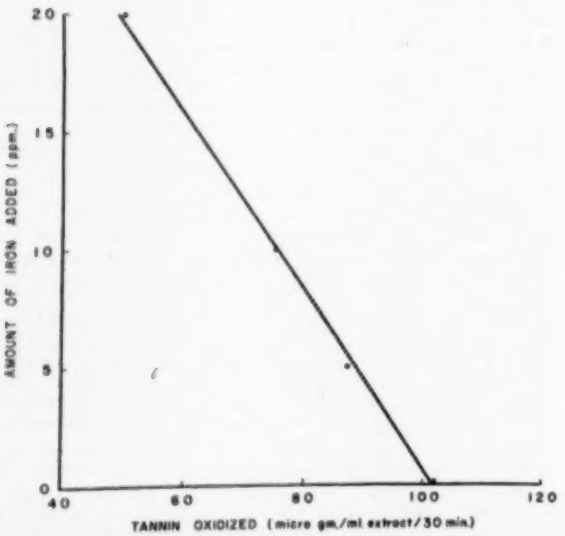

Figure 1. Effect of amount of added iron on rate of oxidation of tannin in frozen cherries.

Effect of sequestering agents. The effectiveness of added phytic acid in inhibiting darkening of cherries as caused by ferric ion is indicated by the data in Table 2.

Effect of added ascorbic acid. The results shown in Figure 2 indicate that ascorbic acid has a significant protective effect for the color of cherries stored frozen for 6 months. The protective effect was apparent immediately upon thawing and at intervals

TABLE 2

The effect of added phytic acid in the prevention of iron-induced darkening in cherries stored frozen 6 months in pliofilm bags

Treatment	Hunter chroma (6 hours after thawing)
Untreated	21.1
Iron added (10 p.p.m.)	17.6
Phytic acid added (0.1%)	22.1
Phytic acid added (0.1%) and iron added (10 p.p.m.)	21.7

up to 6 hours after. The results indicate that although mixtures of ascorbic and citric acids do afford some protection, the effect is less than when ascorbic acid alone is used.

The use of levels of 100 and 300 mg./lb. of these antioxidants gave results similar to those shown in Figure 2, except that the level of protection was directly proportional to the amount used.

Effect of oxygen. Presence of oxygen is detrimental to color retention of frozen cherries, as is shown by the data in Figure 3. The removal of oxygen resulted in an apparent protective effect as measured in the cherries immediately upon thawing, and at intervals thereafter.

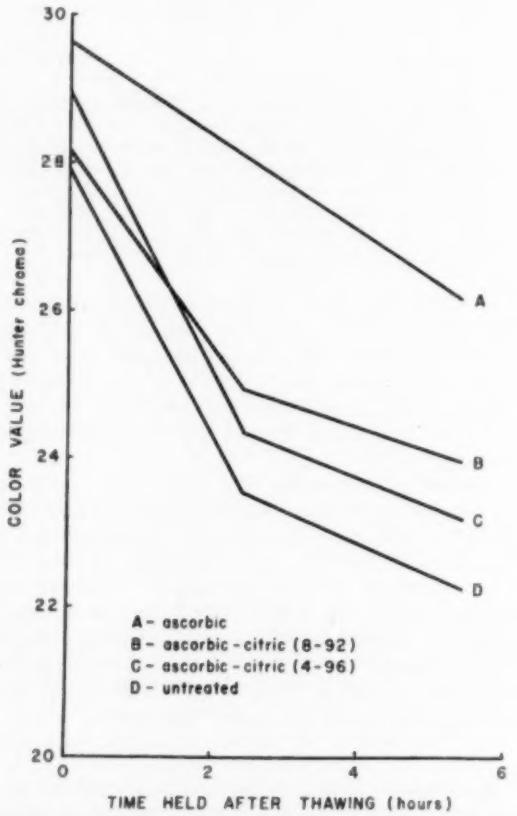

Figure 2. Effect of ascorbic acid and mixtures of ascorbic and citric acids (at a level of 200 milligrams per pound) on the color of cherries frozen in pliofilm bags.

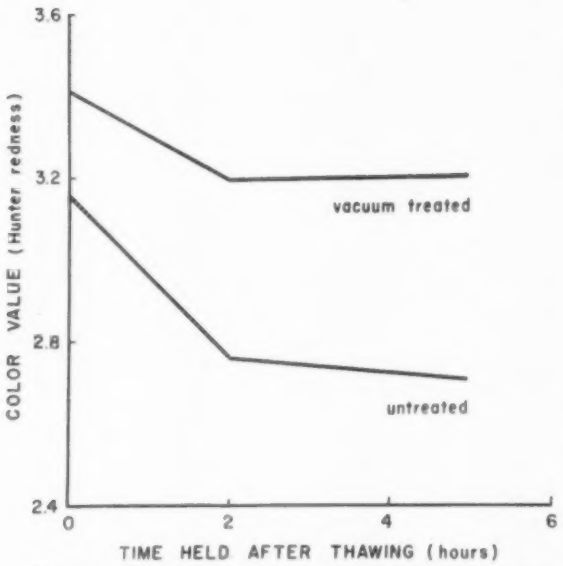

Figure 3. Effect of vacuum treatment on the color of cherries frozen in cans and stored six months.

Effect of various sugars and freezer storage time. In Table 3 data are presented illustrating the effect of various types of sugars on the color of cherries after two intervals of freezer storage.

The color of cherries frozen in corn sirup was better than those packed in sucrose, especially after 8 months' storage. Inverted sucrose sirup had the least protective effect. There appeared to be no particular advantage in using a combination of corn or inverted sucrose sirups with sucrose in protecting the color of cherries.

TABLE 3

Effect of various sugars on the color of cherries frozen in pliofilm bags

Treatment	Color value (Hunter chroma)		
	0 Mo. storage	4 Mo. storage	8 Mo. storage
Sucrose	22.3	22.7	21.2
Corn Sirup	23.7	23.1	23.1
Inverted Sucrose Sirup	22.4	21.4	19.9
Sucrose and Corn Sirup	22.8	21.3	21.5
Sucrose and Inverted Sucrose Sirup	22.2	22.0	19.6

DISCUSSION

Two distinct types of discoloration have been detected in frozen cherries. Tannin is the major reactant in both. Butland has reported that the presence of ferric ions, as contaminants, in maraschino cherries causes a darkening by the formation of dark-colored iron tannates *(1)*. He reported also that enzymatic breakdown products of tannin, such as catechols and gallic acid, form a complex with heavy metals and produce dark-colored compounds. The intensity of the darkening in the frozen cherries packed either in tin or flexible plastic containers was found, in this experiment, to be proportional to the concentration of soluble iron. It has been reported that the presence of oxygen accentuates the degree of such iron-induced darkening *(11)*. This observation was not confirmed in the current experiments. When iron was added at levels of 5, 10, and 20 p.p.m. to cherries frozen in plain tin cans, sealed under 25 inches vacuum, and in flexible bags, without vacuum, no difference in the rate of development or amount of discoloration was observed.

The addition of phytic acid proved very effective in the inhibition of iron discoloration by its sequestering action. The concentration of phytic acid used was greater than calculated as necessary for sequestering action. The excess phytic acid caused a lowering of pH. The rate of enzymatic browning in frozen fruits is, in part, dependent on pH. Thus, the excess phytic acid was found to have a protective effect for the cherries without as well as for those with added iron during the freezer storage period.

SUMMARY

The presence of ferric ions in frozen cherries causes a discoloration which is proportional to the concentration of soluble iron, but is not affected by the presence of oxygen. The presence of cupric ions did not cause as significant a discoloration in frozen cherries. Phytic acid is effective in the inhibition of iron-induced discoloration. Ascorbic acid has a significant protective action on the color of frozen cherries, while mixtures of ascorbic and citric acids afford a lesser degree of protection. The presence of oxygen was shown to be detrimental to the color of frozen cherries. The protective action of corn sirup on the color of frozen cherries appeared superior to that of sucrose, whereas inverted sucrose was inferior.

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The Value of Maleic Hydrazide as a Plant Growth Retardant[a]

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The effects of maleic hydrazide, a plant-growth retardant, are reviewed and discussed. Specific responses are given for the following: berries and small fruits, cotton, carrots, fruit trees, grasses, hedges, onions, potatoes, tobacco, tomatoes, and sugar beets.

Practical agriculturalists are familiar with procedures for increasing the rate of growth and increasing the yields from crop plants. However, there are times and conditions when it is highly desirable to retard rather than stimulate plant growth. Frequently, in the spring, particularly in a so-called early spring, conditions are unusually favorable for early and rapid growth of orchards and small fruits. When the fruit blossoms and the early growth are subjected to a late frost, crop failure ordinarily follows. At such times the fruit grower desperately needs some procedure for delaying the blossomtime until the danger of killing frosts has passed.

Tobacco growers, likewise, would be greatly assisted if a substance or procedure could be developed to prevent the growth of a part of the plant—i.e. the suckers—the removal of which requires considerable time and labor. Carrots, onions, potatoes, sugar beets, and other root crops continue physiological development after removal from the ground. If, during storage, such physiological activities as sprouting of onions, conversion of starch in potatoes to sugar, and the decrease in the sugar content of sugar beets could be delayed, the storage life of such root crops would be lengthened, their market quality conserved, and their food value retained.

These and other practical needs for a means of regulating plant growth have stimulated investigators to evaluate numerous commercial materials of promise. During recent years, hundreds of new organic compounds have been synthesized. Some of these appear to have value as growth regulators and are available in quantities adequate to justify study. In this regard, a factor particularly worthy of study is the possible effect upon plant physiological activity of certain chemical substances.

In this paper, maleic hydrazide, which has attracted widespread interest because of its growth retardant properties, has been selected for review in order to assemble the key findings with respect to the various crops to which it has been applied. Apparently the plant growth inhibition value of this substance was first described by Schoene and Hoffmann *(28)*. Since their study was published, more than 200 articles on the theoretical and practical aspects of maleic hydrazide as a plant-growth retardant have appeared.

[a] Contribution No. 908, Massachusetts Agricultural Experiment Station, Amherst, Mass.

PHYSICAL AND PHYSIOLOGICAL PROPERTIES

According to White *(36)*, maleic hydrazide, first synthesized by Foersterling in 1895, is (a) not irritating to the skin nor toxic by oral ingestion in amounts likely to be found on plants, does not (b) corrode metals ordinarily used in spray equipment, and (c) reduces the rate of plant respiration. Schoene and Hoffman *(28)* found maleic hydrazide to be slightly acid and to form salts readily with alkalies. The free compound was shown to be completely soluble in water at 2000 p.p.m. (0.2%) but did not dissolve completely at a 1% solution. Naylor and Davis *(22)* report that maleic hydrazide is not very soluble in water, but a 0.5% solution can be kept at pH 6.0 and at 5° C. without crystal formation. Darlington and McLeish *(5)* found that the action of maleic hydrazide is, like that of X-rays, specifically directed to growing tissues. They state that other agents have shown some similarity in effect with X-rays, but here for the first time we have a sharp contrast. X-rays break the euchromatin only; maleic hydrazide breaks the heterochromatin only. The new agent may even be a means, therefore, of defining specific kinds of genes in the heterochromatin.

In view of the desirable characteristics of maleic hydrazide, numerous investigators have tested its effects—on berries and small fruits, on carrots, cotton, fruit trees, grasses, hedges, onions, potatoes, tomatoes, tobacco plants, sugar beets, and on some types of flowering plants. The specific findings will be of interest.

BERRIES AND SMALL FRUITS

Commercial strawberry and small fruit growers are perenially concerned with the possible destruction of fruit blossoms by frost. White and Kennard *(35)* sprayed dilutions of 1000, 1500, 2000, and 3000 p.p.m. of maleic hydrazide on grape, strawberry, and black raspberry plants in the late spring to delay blossoming. Blossoming of the grape plants was not delayed, and the secondary buds were actitvated. Blossoming of the strawberry plants was stopped temporarily but resumed—indicating that controlled treatment might enable strawberry growers to avoid crop failures caused by frost damage to the blossoms. Compared to check plants, blossoming of the black raspberry plants was delayed 24 to 38 days. No injury was apparent on plants treated with the lower concentrations of maleic hydrazide. Ferres *(9)* found 1500 p.p.m. of maleic hydrazide applied to Norfolk Giant raspberry at green bud stage produced no noticeable effect on the time of flowering, delayed harvesting 3 or 4 weeks but caused no appreciable effect on the total weight of the crop. Baldwin black currants sprayed with 10, 100, 750, and 1000 p.p.m. of maleic hydrazide during the dormant period, at bud break, and at bud burst showed no delay in flowering or fruiting, but the higher concentrations caused malformation of the leaves and abscission of some of the berries.

Kennard, Tukey, and White *(15)* treated three-year-old raspberry plants with 500, 1000, 1500, and 2000 p.p.m. of maleic hydrazide solutions. All applications of maleic hydrazide inhibited vegetative development and delayed blossoming and fruit maturation, but the 2000 p.p.m. solution burned much of

the foliage and killed new shoots. Spring applications of 50 and 200 p.p.m. of maleic hydrazide solutions delayed the blossoming and fruit maturation of black raspberries without reducing the yield, size, and quality of fruit or damaging the plants. White *(34)* concluded that two-year-old vigorous Bristol black raspberries afforded the best example of the effects of maleic hydrazide in delaying blossoming. The treated plants blossomed 24 to 38 days later than check plants and their fruit matured 16 to 23 days later than check plants. Fruit set was good, and no difference in size or flavor of the berries was apparent.

COTTON

For successful cotton-growing, preventing or materially inhibiting the growth of noxious weeds and grasses is a prime requirement. Currier and Crafts *(4)* sprayed a mixture of young barley, grass, and cotton plants with a 0.2% maleic hydrazide solution; after 6 weeks the barley and grasses were completely dead, but the cotton plants were unaffected. They concluded that this compound may prove to be a valuable selective herbicide and would seem to justify thorough testing. Zukel *(41)* and Erickson, Brannaman, Hield, and Miller *(8)* agree that maleic hydrazide may be used effectively as a herbicide. McIlrath *(19)* reported that all spray treatments with maleic hydrazide increased the length of time from planting cotton seed to the maturing of the first boll. Moreover, chemical analysis of sixth and seventh leaves of control plants and plants sprayed 26 days before harvest with a 2400 p.p.m. solution of maleic hydrazide showed definitely more sucrose, total sugars, starch, cellulose, and total carbohydrates in the leaves from the treated plants. On the other hand, Naylor and Davis *(22)* think that because of the uniform effectiveness of maleic hydrazide as a growth inhibitor, it seems unlikely that the chemical will be generally useful as a selective herbicide. Furthermore, Josephson *(14)* found that maleic hydrazide delays the growth and flowering of corn and concluded that any concentration that will delay flowering or induce pollen sterility will also greatly reduce yields. Although the early papers seemed to indicate that maleic hydrazide offered promise as a selective herbicide for noxious weeds and grasses growing in cotton, subsequent studies have indicated that it is not an adequate selective herbicide for cotton.

CARROTS

The commercial vegetable grower is very anxious about the sprouting of carrots during storage and is desirous of preventing it and also the financial loss entailed. Wittwer, Sharma, Weller, and Sell *(40)* obtained almost complete inhibition of sprout growth in carrots held in storage for 3 months at 50° F. by spraying the carrot foliage 4 days before harvest with a 2500 p.p.m. solution of maleic hydrazide; the maleic hydrazide produced no significant alteration in the amount of dry matter, carotene, carbohydrate, or Kjeldahl nitrogen in the stored carrots. Crafts, Currier, and Day *(3)* treated 20-day- and 35-day-old carrot plants with 0.0, 0.1, 0.2, and 0.4% maleic hydrazide solutions and found that the more mature plants were less severely affected.

FRUIT TREES

Smock, Edgerton, and Hoffmann *(29)* reported that spraying Yellow Transparent, Duchess, Wealthy, and McIntosh apple trees between 7 and 36 days before harvest with 20 to 370 p.p.m. of maleic hydrazide solutions delayed slightly the normal softening rate of apples on the trees and that the sprayed apples respired somewhat more slowly after harvest than the unsprayed fruit, all of which should decrease bruising during handling and marketing. The authors point out the need for a critical evaluation of the concentration of maleic hydrazide, timing of spraying, formulation, possible secondary effects and influence of weather. White and Kennard *(35)* were unable to delay blossoming of apple trees sprayed in the early pink stage of the flower buds. Ferres *(9)* applied 10, 100, 750, and 1000 p.p.m. maleic hydrazide to Laxton's Superb apples before and after bud break with no effect on the subsequent development of the buds or the time of flowering. Erickson, Brannaman, Hield, and Miller *(8)* found that maleic hydrazide applied during late winter delayed spring growth of Valencia orange and grapefruit trees with no noticeable effect upon the quality of the fruit, but the Washington Navel orange fruit was of smaller size, and the yield per tree was larger.

GRASSES

Schoene and Hoffman *(28)* sprayed turf with 8, 4, 2, and one pounds of maleic hydrazide dissolved in 200 gallons of water. One pound per acre gave a slight retarding effect, 2 pounds inhibited growth for one to 2 weeks, 4 pounds inhibited for 4 weeks, and 8 pounds per acre inhibited growth for more than 2 months. Growth of bluegrass, bentgrass, crabgrass, plantain, and chickweed was inhibited. Currier and Crafts *(4)* reported that various types of grasses react quite differently to maleic hydrazide and young plants respond to a much greater extent than older plants. Young water grass and Johnson-Grass plants sprayed with 0.2% maleic hydrazide stopped growing, developed anthocyanin pigmentation, and finally died. Older plants showed some response but survived. Engel and Ahlgren *(7)* sprayed New Jersey turf consisting of Kentucky bluegrass, colonial bentgrass, perennial ryegrass, and redtop with 0.6 to 2.4 pounds per acre of maleic hydrazide dissolved in 200 gallons of water. They observed marked reduction in growth of the turf grasses in 14 days after treatment. Six weeks after treatment all the treated turf was considered normal. Apparently all the grasses were affected. Stiver, Rea and Johnston *(31)* treated test plots of Johnson grass, 12 inches tall, with maleic hydrazide at the rate of 2, 4, and 6 pounds per acre dissolved in 100 gallons of water. They state that maleic hydrazide is a growth inhibitor and, at the rates used, has little killing effect; it did stop top growth and seed setting.

HEDGES

Knott *(17)* became interested in the possibility of reducing the rate of growth of ornamental hedges. To test the possibility of reducing the number of clippings during a summer season, he sprayed a *Pyracantha crenulata* Roem., firethorn hedge, 96 feet long with 0.5% maleic hydrazide solution. New shoot growth was checked completely for a month and retarded greatly for another month, with no apparent injury to the evergreen foliage or to any partly developed berries.

ONIONS

Onions that sprout during storage represent a loss of the onions as well as a labor and storage expense. Wittwer and Sharma *(39)* were able to control storage sprouting of onions by a preharvest spray of the foliage with a 2500 p.p.m. solution of maleic hydrazide at the rate of 75 gallons per acre. Observations after 5 months' of storage showed no sprouting; gross longitudinal sections of the onions revealed normal internal structure, with the flavor, color, and odor apparently unaffected. Also, Wittwer, Sharma, Weller and Sell *(40)* report that spraying intact onion plants 2 weeks before harvest with a 2500 p.p.m. maleic hydrazide solution completely inhibited sprouting and root growth of onions stored at 55° F. for 5 months. Greulach and Atchison *(10)* selected Southport Yellow Globe onion bulbs for uniformity of size and treated them with 1, 100, 1000, and 2000 p.p.m. solutions of maleic hydrazide. The inhibitions of total growth and of cell division were both correlated with the concentrations of the maleic hydrazide solutions, but the effect on cell division did not occur simultaneously with the effect on total growth. They suggest that the lower concentrations inhibit cell division but not cell enlargement, whereas the higher concentrations inhibit both. Isenberg, Odland, Popp, and Jensen *(13)* found that maleic hydrazide sprayed on the foliage of onion plants affects respiration through the partial inactivation or inhibition of one or more of the dehydrogenases. The rapidity of the effects of the chemical is governed by the rate of its adsorption into the plant. Wittwer and Paterson *(38)* reported that most of the highest yielding hybrid onions have poor keeping qualities. A preharvest foliage spray of maleic hydrazide has prolonged by several months the storage life of the hybrids. Time of applying maleic hydrazide is very important, for effectiveness of the chemical is dependent upon its absorption by the leaves; however, premature treatment will result in hollow or puffy bulbs, which keep very poorly in storage. Thus, field tests in which maleic hydrazide was applied one or 2 weeks before harvest showed no reduction in yield.

POTATOES

Potatoes have a tendency to sprout during the last half of the winter storage period. Sprouting lowers the market quality of the potatoes and reduces their sale value. Thus, potato growers are intensely interested in any feasible procedure that will eliminate this undesirable feature. Paterson, Wittwer, Weller, and Sell *(24)* applied sprays of maleic hydrazide to Cobbler and Pontiac potato vines 4 to 7 weeks before harvest and prolonged the dormancy of tubers held in storage for seven months at 45° to 55° F. There was no shriveling, little or no deterioration of quality, and no reduction of yield of U. S. No. 1 potatoes.

Sweetman *(33)* found in a survey of trade preferences that very light-colored potato chips are desired, and her investigation revealed that the color of chips is correlated with the sugar content of the potatoes from which they are made. Compared to untreated controls, potatoes sprayed by Paterson, Wittwer, Weller, and Sell *(24)* showed an appreciable reduction in the accumulation of reducing sugars, thus assuring a superior colored potato chip.

Marshall and Smith *(18)* inhibited sprouting in Green Mountain potatoes with a 2500 p.p.m. maleic hydrazide solution. The accumulation of reducing sugars in white potatoes stored at low temperatures causes an objectionable brown or deep tan color in processed potatoes and, therefore, is a troublesome problem to processors of potato chips, dehydrated potatoes, canned whole potatoes, and frozen French fried potatoes. Highlands and Licciardello *(12)* sprayed Kennebec and Katahdin potatoes grown on Caribou loam Aroostook soils with 150 gallons of 1000 and 2000 p.p.m. of maleic hydrazide solutions per acre 37, 27, and 20 days prior to harvest. After harvest the potatoes were stored at 40° F. for 6 months. Then, typical tubers were assayed for reducing sugars. The treated potatoes showed no significant reduction in reducing sugars, and the appearance and color of potato chips prepared from like samples of treated and untreated potatoes showed no significant differences within the variety. Ross *(26)* has shown that reducing sugars in Katahdin varieties stored at 40° F. for 150 days increased from an initial 1.4 to 5.7%, and Green Mountain tubers under the same storage conditions showed an increase from 3.8 to 6.3%.

Kennedy and Smith *(16)* applied 0.1, 0.01, and 0.001% solutions of maleic hydrazide to Sebago potatoes at four dates during the growing season and found in general that high concentrations applied early in the growing season caused plant injury but applied late in the season caused a reduction of sprouting during storage. Edwards *(6)* commented upon the need for storing potatoes from the April harvest until the short supply season of September and October. The Sebago, the popular variety in Southern Australia, is a notoriously poor keeper at temperatures ranging from 30° to 60° F. The losses due to excessive sprouting and loss of weight and quality make storage of this variety uneconomical. Edwards sprayed typical, April-harvested, Sebago potatoes with a 1250 p.p.m. maleic hydrazide solution on June 1. After 6 months of storage the treated potatoes showed a weight loss of 17.7%, with 44.7% marketable, whereas the controls had a weight loss of 27.6%, with 28.0% marketable. Wittwer and Paterson *(38)* reported that by adjusting concentration of the maleic hydrazide solutions sprayed on potato vines, any desired degree of sprout inhibition or storage dormancy may be obtained—a dormancy can be so complete that the potatoes are useless for seed purposes. Wittwer and Paterson also reported that low storage temperatures (below 45° F.) are conducive to sugar accumulation in potatoes; maleic hydrazide has the very desirable characteristic of partially blocking the enzymatic conversion of starch to sugar, thus the treated tubers produce lighter-colored potato chips. Salunkhe, Wittwer, Wheeler and Dexter *(27)* working with Russet Rural, Irish Cobbler, and Sebago potatoes found that a preharvest spray of 2500 p.p.m. of maleic hydrazide increased the specific gravity of the tubers and improved the color of the potato chips produced from them. If maleic hydrazide could always be depended upon to improve the color and quality of potato chips, dehydrated potatoes, canned whole potatoes and French fried potatoes, it could become a very valuable adjunct to the potato industry, but as yet there is some question concerning the actual influence, since it is difficult to separate the maleic hydrazide effect from storage temperatures and other variables known to affect quality.

TOBACCO

In the growing and harvesting of tobacco, much hard labor and expense are involved. Topping and suckering tobacco is a grimy, time-consuming job, and all tobacco growers would welcome any feasible procedure that would eliminate or reduce this necessary expense in producing good quality tobacco. Nelson *(23)* has commented that the best topping stage for Havana Seed Tobacco is the time when it begins to bloom; the tendency of the plant is to produce darks and mediums in the upper leaves and lights to seconds in the lower portion of the plant; the lower nine to eleven leaves usually include the bulk of the high quality tobacco; topping retards seed formation and activates vegetative growth; ordinarily 12 to 18 leaves are left on the plant; low topping reduces variability in the size of the leaves and hastens maturity. Peterson *(25)* suppressed the growth of suckers by applying solutions of maleic hydrazide, pH 6.6, to the upper 6 or 7 leaves of tobacco plants after topping, but the treatment caused no significant effects upon the yield, quality, or burning properties of the cured tobacco leaves. Naylor *(21)* observed that tobacco plants treated with 0.2, 0.4, or 0.8% maleic hydrazide solutions produced no new flowers, but plants treated with 0.1% maleic hydrazide produced some flowers that grew slowly. Ciferri *(2)* reported that flowering of Virginia bright tobacco plants was retarded or inhibited by spraying with maleic hydrazide; 100 p.p.m. caused a delay of 7.3 days; 200 p.p.m., a delay of 8.7 days; 400 p.p.m., a delay of 10.7 days; and 800 p.p.m. inhibited flowering. Naylor and Davis *(22)* stated that maleic hydrazide may readily enter a plant through the leaves or the roots: flowering in Turkish tobacco was prevented either by adding maleic hydrazide to the soil or by spraying the foliage.

TOMATOES

Adult tomato plants grown by Bertossi *(1)* in a 1000 p.p.m. solution of maleic hydrazide showed marked retardation of flower buttons without growth retardation; he obtained the same results by spraying the areal portion of the plants. Schoene and Hoffmann *(28)* found that the inhibition of the growth of tomato plants sprayed with ammonium salt of maleic hydrazide was proportional to the amount of maleic hydrazide used. Crafts, Currier, and Day *(3)* sprayed 20- and 35-day-old tomato plants with 0.0, 0.1, 0.2, and 0.4% solutions of maleic hydrazide and measured the height of the plants during a two-month period. The extent of inhibition of growth increased with increase in concentration of solutions and decreased with increase of the age of the plants. Naylor and Davis *(22)* reported that tomato plants treated with maleic hydrazide were stunted.

SUGAR BEETS

Sugar beets, as a source of sugar, were introduced into this country about 1870, and now about 900,000 acres are devoted to the yearly crop. Highly efficient factories annually process more than 10 million tons of beets to supply more than a fifth of the 7 million tons of sugar consumed in this country per year. Since the factories cannot process the beets as fast as they are harvested, a considerable portion of the crop must be stored; ordinarily the last portion of the crop is not processed for 3 or 4 months after harvest. During storage, physiological processes are active, the rate increasing with increase in temperature; the sugar accumulated in the beets is converted to carbon dioxide and water, and energy in the form of heat. Hansen *(11)* stated that stockpiled sugar beets may lose up to a pound of sugar per ton per day, and the yearly loss amounts to about $1,500,000. According to Stout *(31)*, the respiratory heat of sugar beets at 58° F. is about 81 B.T.U. per ton per hour; Stout, McBirney, and Fort *(32)* stated that a 50,000-ton pile of beets at 41° F. gave off as much heat every 24 hours as is produced by burning 2 tons of coal. It is evident from these statements that there is an urgent need for some efficient means of reducing the respiratory rate of sugar beets after harvest. Wittwer and Paterson *(38)* sprayed maleic hydrazide 2500 p.p.m. solutions on sugar beet foliage 2 to 6 weeks before harvest and completely inhibited all sprout and root growth, maintained several degrees lower temperatures in the storage piles, reduced respiratory losses,

slowed down all metabolic processes that cause destruction of sugar, and reduced sugar loss to less than 1% as compared with a 12% loss in the untreated controls during 35 days of storage. Mikkelsen, Griffith, and Ririe *(20)* increased sucrose content 6.2% and root and sugar yields per acre by spraying sugar beet foliage with maleic hydrazide. Wittwer and Hansen *(37)* obtained about a 10% increase in the sucrose content of sugar beets by applying maleic hydrazide as a preharvest foliage spray; yield estimates showed no influence of the treatment on the tonnage of beets harvested.

DISCUSSION

The investigations that have been reported during the past 4 or 5 years concerning the effectiveness of maleic hydrazide as a plant-growth regulant have revealed numerous possible practical applications. However, the results that can be obtained with this material depend upon the amount of maleic hydrazide that is absorbed by the plant and this in turn is regulated by the rate and duration of absorption. Without doubt the rate of absorption varies with different species of plants and also most likely with different strains of a species of plant just as it is well recognized by dental caries investigators that different strains of Albino rats are markedly different in their susceptibility to the development of dental caries. The duration of absorption is another highly important factor i.e. suppose the foliage of a field of a commercial crop which had been efficiently sprayed with a water solution of maleic hydrazide was subjected to a heavy shower or an unanticipated rainy day. Obviously, the effectiveness of the maleic hydrazide would be greatly influenced by the length of time intervening between the application of maleic hydrazide solution and the rainfall.

Various investigators who have studied the value of maleic hydrazide as a plant-growth regulant caution that the results that may be obtained by the application of maleic hydrazide to various types of food-producing plants are likely to be significantly influenced by numerous factors. Some of these are concentration of the solutions used, the type of plant, the stage of development at the time the spray is applied, the amount and type of fertilizer used to feed the plant, the nature and condition of the soils on which the plant is growing and such climatic conditions as the atmospheric and soil temperatures, the amount and distribution of rainfall, the relative humidity, and the amount and distribution of bright sunshine.

The consuming public, naturally, will be very much concerned regarding the possibility of any toxic effects developing from the use of maleic hydrazide. As noted above, White *(36)* has reported that maleic hydrazide is not toxic by oral ingestion in amounts likely to be found on plants, but Darlington and McLeish *(5)* conclude their report of the action of maleic hydrazide on plant cells with the statement that "Since nearly all chromosome-breaking agents have so far proved to be cancer-producing as well, we must hope that the agricultural use of this new agent will not be encouraged before suitable tests are made." The general conclusion that may be drawn from the reports in the literature is that under many agricultural conditions maleic hydrazide offers considerable promise for regulating the rate of growth and development of a number of important food crops.

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Stabilization of Dehydrated Cabbage by In-Package Desiccation[a]

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Montmorillonite was tested as a possible substitute for calcium oxide as an in-package desiccant for dehydrated cabbage. While somewhat less efficient than lime, it permitted a substantial stabilization of the product at a sacrifice of only a few percent of container volume. A commercial two-way-stretch paper was found to have desirable permeability and mechanical properties for use as a desiccant container. It can be fabricated into bags and the bags filled on automatic heat-sealing equipment. A new rehydration test for dehydrated cabbage is described.

During World War II, research at this Laboratory demonstrated that dehydrated vegetables can be effectively stabilized against nonenzymatic browning and other changes by in-package desiccation (IPD). Results of this and subsequent work have been reported in a number of publications *(3, 5, 6, 15)*. The in-package desiccation process consists of packing the dehydrate, together with a bag of desiccant, in a moisture-impermeable container. At the time of packing, the dehydrated food contains several percent of moisture, but during subsequent storage some of this moisture is gradually transferred to the desiccant by diffusion. A Quartermaster Corps specification for the process was issued *(14)* shortly after V-J day but was not used for regular procurements. Interest in the process was renewed, however, by military needs for high-quality dehydrated foods for operations in Korea, and by the finding that IPD is very effective in preserving quality and preventing caking in orange juice powder *(12)*.

Active calcium oxide was selected by the Quartermaster Corps as the preferred desiccant for dehydrated fruit and vegetable products *(14, 15)*. However, at the beginning of hostilities in Korea it was uncertain whether a suitable lime and an inexpensive and satisfactory container for lime would be available. Tests were therefore initiated on montmorillonite, another desiccant which showed some promise as an alternate to lime. Although a greater volume of montmorillonite would be required, the additional sacrifice of container capacity was expected to be small. This desiccant has the advantage of swelling to a negligible extent as it takes up moisture, whereas commercial limes may swell 60% to 100% or more in volume.

Simultaneously experiments were begun on two relatively new materials from which bags could be fabricated for holding lime or other desiccant. Because of the force exerted by expanding lime and its tendency to dust, the military specification *(14)* requires it to be packed in a kraft paper bag within a heavy jean cloth outer bag. Such a composite container is relatively expensive. One of the new materials is a two-way-stretch paper; the other, a nonwoven cloth. Both are available with a heat-sealing coating which permits them to be made into bags and the bags filled on automatic machinery.

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Cabbage was chosen as the dehydrated product for these tests because of military interest in a leafy green vegetable suitable for use in salads under conditions where fresh vegetables cannot be provided. Furthermore, although cabbage is one of the least stable of the dehydrated vegetables, its stability can be substantially increased by IPD *(6)*. Because of its low bulk density compared to other dehydrates, the sacrifice of volume involved in introducing the required amount of desiccant is relatively small.

MONTMORILLONITE COMPARED WITH LIME

Commercial dehydrated cabbage containing 4,100 p.p.m. sulfite as SO_2 and adjusted to 4.3% moisture (moisture-free basis) was packed in No. 10 cans with or without a desiccant. Five series of 7 to 12 cans each were packed as shown in the first four lines of Table 1. The lime was a powdered recalcined hydrated lime previously found to meet the military specification *(14)*; the montmorillonite was Desiccite 25,[5] manufactured by Filtrol Corp., Los Angeles, Calif. The air within each can was displaced with nitrogen; the container atmosphere had a final oxygen content of about 2%.

The cans of Series A (control) were immediately placed in storage at —10° F. (—23.3° C.). The others were held 30 days at 75° F. (23.9° C.) and were then transferred to a room maintained at 100° F. (37.8° C.). The storage times in Table 1 were counted from the day the cans of Series B-E were placed at 100° F. Single cans were withdrawn periodically and the contents tested for rehydration ratio and soluble color. More complete analyses were carried out at the end of 6 months, as indicated in the table.

To obtain material for testing, a can was opened in a room maintained at 5 to 10% relative humidity and the contents thoroughly mixed. Samples for moisture, soluble color, and sulfite determinations were ground in a laboratory mill in this room, with care taken to minimize contact with the air.

Moisture contents were determined on samples ground to pass a 2-mm. screen and dried 6 hours in a vacuum oven at 70° C. They are expressed on a moisture-free basis. Values obtained on dehydrated cabbage by this method were found to agree closely with those obtained by the method of Makower *et al. (10)*, although this is not true for some other dehydrated vegetables.

Sulfite contents were determined by the iodine titration method of Prater, Johnson, Pool and Mackinney *(13)* and are expressed as p.p.m. SO_2.

Measurement of the rehydration characteristics of dehydrated cabbage is difficult because a large and variable quantity of free water is trapped between the membranous shreds. For this reason a new test was developed in which nearly all the water adhering to the surfaces was removed by centrifugation. Twenty g. of dehydrated cabbage was soaked in 240 ml. of water at room temperature for 1 hour and was then transferred to an 8-inch centrifuge basket lined with canvas. The centrifuge was brought to a speed of 3,000 r.p.m. in 1 minute, maintained at this speed (±100 r.p.m.) for 10 minutes, and quickly stopped. The weight of the centrifuged material was divided by 20 to give the rehydration ratio. Variations of centrifuge speed within the limits given were found to have a negligible effect on the measured ratio. The values given in Table 1 are averages of 2 to 4 replicate determinations. The average difference between duplicate determinations on a single sample was 0.06 unit.

Nonenzymatic browning was measured by the soluble-color method *(2)*. The values given in the table are the optical densities of 2.5% water extracts measured in a 2 cm. cell with light of 420 mμ wavelength and are corrected for sample moisture content.

Carbon dioxide was measured with an Orsat apparatus in the usual manner and is expressed as percentage of container atmosphere, by volume.

[5] Mention of this product and others does not imply that they are recommended by the Department of Agriculture over others of a similar nature not mentioned.

TABLE 1

Effects[1] of storing dehydrated cabbage with and without desiccants

	Series				
	A	B	C	D	E
Wt. of cabbage, g.	680	680	543	660	680
Type of desiccant	None	Lime	Mont.	Mont.	None
Wt. of desiccant, g.	0	113	339	170	0
Temp. of storage, F.	—10	100	100	100	100
Moisture, when packed, % MFB	4.3 (all series)				
Moisture, 6 mo., % MFB	3.9	0.5	1.0	1.7	4.9
Sulfite, when packed, p.p.m. SO_2	4100 (all series)				
Sulfite, 6 mo., p.p.m. SO_2	3700	3600	2600	2400	800
Rehydration ratio, 0 mo.	2.48	2.55	2.62	2.52	2.56
Rehydration ratio, 2 mo.	2.58	2.60	2.64	2.60	2.47
Rehydration ratio, 4 mo.	2.57	2.59	2.65	2.56	2.40
Rehydration ratio, 6 mo.	2.56	2.56	2.61	2.50	2.23
Soluble color,[2] 0 mo.	0.110	0.115	0.117	0.123	0.125
Soluble color, 2 mo.	.110	.131	.133	.145	.268
Soluble color, 4 mo.	.108	.145	.156	.168	.544
Soluble color, 6 mo.	.109	.144	.157	.181	1.340
CO_2, 6 mo., % of gas volume	0.2	0.2	1.0	2.0	—

[1] All values are averages. Local differences undoubtedly existed within a can, particularly in the early stages of storage.

[2] $\Delta E^{2.5\%}_{2\ cm.,\ 420\ m\mu}$ See reference *(2)*.

A preliminary subjective evaluation of the samples indicated that Series B and Series C had undergone less deterioration than Series D during 6 months' storage at 100° F., while Series E was extremely unpalatable. For this reason organoleptic appraisal was limited to a comparison by the triangle test of Series A (low temperature control) and Series D (packed with 6 oz. montmorillonite). The results are given in Table 2.

Table 1 shows that of the desiccants, 113 g. (4 oz.) of lime was the most effective in reducing the moisture content of the dehydrated cabbage. Montmorillonite (339 g. or 12 oz.) was second in this respect, and 170 g. (6 oz.) of montmorillonite was third. In the absence of any desiccant the samples (Series E) stored at 100° F. increased slightly in moisture content. This phenomenon has been observed in other dehydrated vegetables where extensive nonenzymatic browning has occurred in storage.

TABLE 2

Triangle tests of Series A and Series D after 6 months' storage at 100° F. (37.8° C.)

Quality factor	Total judgments	Correct judgments	Correct judgments needed for significance	
			P = 0.05	P = 0.01
Flavor	34	19[1]	17	19
Color	26	22[2]	14	15

[1] Of these 12 indicated Series A had less off-flavor, 7 indicated Series D had less.

[2] Of these 11 preferred Series A; none preferred Series D, and 11 did not indicate preference.

The apparent loss of 0.4% moisture in the low-temperature control is probably experimental error, although it is somewhat greater than that ordinarily encountered with this moisture method.

The most striking changes occurred in the optical density values of water extracts. Increases of 0.005 to 0.015 unit reflected the slight browning that took place during the 30-day preconditioning period at 75° F. (23.9° C.). The rate of browning during subsequent storage at 100° F. was in inverse order to the effectiveness of the desiccants in reducing the moisture content of the cabbage. The optical-density increase during 6 months for Series E, without desiccant, was over 20 times as great as that for Series D, packed with the smaller amount of montmorillonite. These differences in degree of browning were equally striking to the eye (Figure 1).

Legault and coworkers *(8)* took an optical density value of 0.300, or an increase of 0.190 during storage, as their arbitrary "limit of palatability" for dehydrated cabbage, based upon

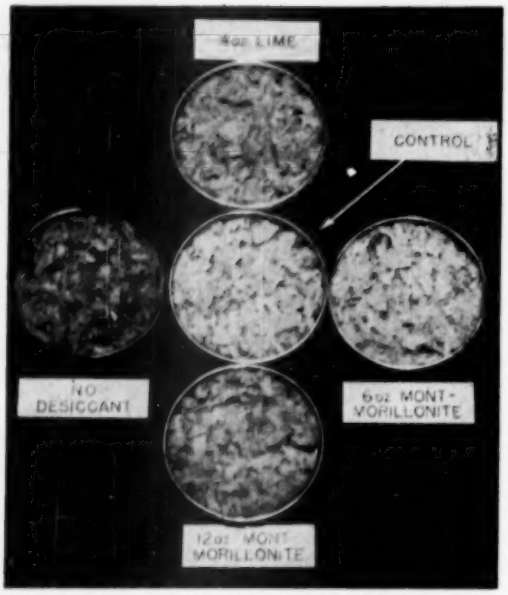

Figure 1. Samples of dehydrated cabbage reconstituted in cold water after storage. Control held at —10° F.; others held one month at room temperature and 6 months at 100° F. Samples packed with or without desiccants as indicated.

appraisal of the cooked product by a panel of judges. The series with 1PD had browned to only a fraction of this limit at the end of the experiment, while Series E, without a desiccant, had exceeded it several fold.

The carbon dioxide values increased with increasing degree of browning,[c] as has frequently been reported for cabbage and other dehydrated vegetables.

In 19 out of 34 judgments in the triangle test, the judges correctly identified duplicate samples by flavor, a fraction just significant at the 1% level of probability. However, of the judges who correctly identified the duplicates more than a third thought the sample (Series D) stored at 100° F. with 1PD had less off-flavor than the control (Series A). Eighty-five percent of the judges correctly identified the duplicates by color; of these all who indicated a preference favored the control.

TESTS ON BAG MATERIALS

A suitable material for the desiccant container must be sufficiently permeable to water vapor not to retard seriously the transfer of moisture from the product to the desiccant. The permeability requirement has not been established in terms of any standardized water-vapor-transmission test. For this reason a practical test was carried out in which Promset 831-X (Mid-States Gummed Paper Co., Chicago, Ill.)[b] and Lantuck 84-A 2030 with PACO TSMVT Heat Seal No. 50 (Paper Affiliates Dept., Nalco, Inc., New York, N. Y.)[b] were compared with 10-oz. duck. The latter was assumed to be fully as permeable to moisture as the jean cloth bag with kraft liner prescribed by the present military specification.

Commercial dehydrated cabbage (650 g.) having a moisture content of 3.8% (moisture free basis) by the Makower method *(10)* was weighed into each of six No. 10 cans. Duplicate bags of each of the 3 materials were prepared, filled with 80 g. of powdered calcium oxide meeting the military specification *(14)*, and weighed to 0.1 g. One bag was placed on top of the cabbage in each can, the lid was placed in position but not sealed, and the cans were stored in a room controlled at 34° C. (93° F.). The cans were inverted to insure close contact between the cabbage and the dessicant packets, and a weight was placed on each can to prevent leakage around the lid. Periodically the bags were removed, reweighed, and immediately returned to the cans. Table 3 shows the average weight increases of the duplicate bags after various periods. It is apparent that the heat-sealable materials offered very little more resistance to the transmission of water vapor under these conditions than did the 10-oz. duck.

TABLE 3

Average increases in weight of desiccant (lime) packets of various materials at 94° F. (34° C.)

Time	Bag material		
	10-oz. Duck	Promset	Lantuck
	g.	g.	g.
45 hours	4.0	3.9	3.5
13 days	13.2	12.4	12.4
19 days	16.2	15.2	15.3
52 days	21.0	20.9	20.8
149 days	22.9	22.6	22.6

To test whether bags made of Promset would permit a lime desiccant to expand during hydration without rupture of the material itself or of the heat seal, a number of tests were conducted simulating unfavorable conditions that might occasionally be encountered in commercial practice. The general procedure was to place heat-sealed bags of pelletized lime desiccant in the bottom of a No. 10 can, cover it with 3 pounds of sand, and leave it for a day or longer over saturated sodium chloride solution in an evacuated desiccator. The bags were either filled with lime so that no headspace remained or the lime was shaken to one end and the bag folded over in such a way as to form a constriction. Under these conditions the lime rehydrated fully and rapidly. The results with the bags sealed on automatic equipment showed that the material stretched during hydration of the lime. The stretch thus aids in avoiding rupture of the bag. The width of the heat seals was somewhat reduced, however, indicating that in practice care should be taken to avoid pinching off the unfilled part of the bag when it is placed in the outer container.

MOISTURE EQUILIBRIUM BETWEEN CABBAGE AND MONTMORILLONITE

Because of the nature of the water-vapor isotherm for lime, it is simple to calculate the amount of this desiccant that must be packed with a given weight of a dehydrated vegetable in order to reduce its moisture content from one value to another when final equilibrium is achieved. The moisture-absorbing capacity of pure calcium oxide is 32.1% on a dry-weight basis. Commercial lime desiccants may have a lower capacity, but this can be readily measured. With desiccants which dry by adsorption, such as montmorillonite, the relationship is not a simple one. It can be calculated only if reliable isotherms are available for both the desiccant and the dehydrated product. A comparison of published and unpublished data on the water-vapor relationships of dehydrated cabbage showed a serious lack of agreement in the low-moisture range. For this reason a direct measurement was carried out on the moisture relationships between a lot of commercial dehydrated cabbage and one of a montmorillonite desiccant.

Approximately 50 g. of dehydrated cabbage at 4.25% moisture content (moisture-free basis)[d] was placed in tared, self-sealing mason jars and weighed to 0.001 g. In each jar was placed a tared weighing bottle containing a known weight of Desiccite 25. The weights of desiccant in each set of 10 samples formed a roughly logarithmic series ranging from 2.5 g. to 90 g. One set of jars was stored at 75° F. (23.9° C.), and the other set at 100° F. (37.8° C.). Periodically the samples were taken to a low humidity room (5-10% R.H., 70-80° F.) and the weights of cabbage and of desiccant determined. After 308 days the cabbage samples were removed and their moisture contents determined.

[c] The absence, within experimental error, of CO_2 in Series B was to be expected because of the presence of lime.

[d] This value was obtained by drying triplicate ground samples over magnesium perchlorate in a vacuum desiccator at room temperature for 4½ months (to constant weight). The value obtained by drying in a vacuum oven for 6 hours at 70° C. (158° F.) was 4.2%.

Figure 2 shows the relationship between the weight increase of the desiccant and the moisture content of the cabbage, the latter being determined both directly and by calculation from the original moisture content and the measured weight losses. The circles fall closely about a smooth curve passing through the origin except that the three samples of lowest moisture content are slightly above the curve. Since these samples showed weight losses of 0.15 to 0.18% during the period from 5 to 10 months, it is assumed that these had not reached complete equilibrium at the end of the experiment. It is well known that the rate of drying of dehydrated vegetables becomes extremely slow as the moisture content approaches zero.

The squares represent corresponding points obtained on the 3 samples stored at 75° F. with the smallest quantities of desiccant. The fact that they fall on the curve for 100° F. indicates that the temperature coefficient for the relationship plotted here is small. Seven additional points for samples held at 75° F. are not shown, but they would fall above the 100° F. curve with an

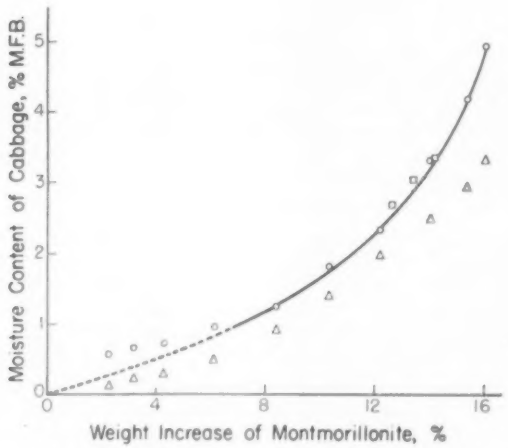

Figure 2. Relationship between average moisture content of cabbage and weight increase of montmorillonite desiccant after 10 months' storage at 75° F. (squares) or at 100° F. (circles and triangles). Triangles represent cabbage moisture values calculated from original moisture content (4.25%MFB) and weight loss during storage.

increasing divergence at low moisture contents. From the weight losses at 5 and 10 months it was apparent that a much longer period would have been required for equilibrium to be reached.

The calculated and directly measured moisture contents of the 10 samples at 75° F. agreed within the limits +0.13% to —0.16%. In the case of the samples at 100° F., deviations ranged from —0.32% to —1.59% as can be seen from the separation of the corresponding circles and crosses in Figure 2. This presumably represents moisture or other volatiles produced during the storage period. Dunker and coworkers *(1)* reported increases in the moisture content of tomato flakes stored at 100° F., which were greatest in the samples of highest initial moisture content. The same effect has been observed at this Laboratory with other dehydrated vegetables after they had been stored under conditions that led to excessive browning.

From the equilibrium curve drawn in Figure 2 and bulk density values for the desiccant and the dehydrated cabbage,* the curves shown in Figure 3 were computed. From these one

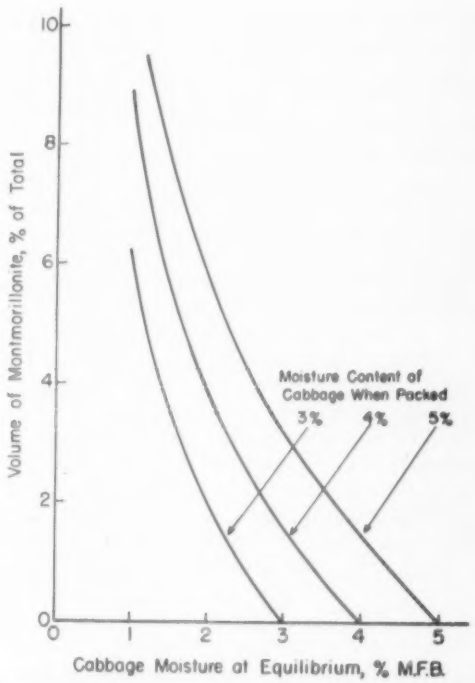

Figure 3. Volume of montmorillonite desiccant required to dry dehydrated cabbage from initial moisture contents of 3, 4, or 5% to lower values. Desiccant volume is expressed as percentage of total container volume. Bulk densities assumed: Cabbage, 13.84 lb./cu. ft.; Desiccant, 60 lb./cu. ft.

can estimate the percentage of the total container volume which will be occupied by the desiccant if the moisture content of the cabbage is to be lowered from 3, 4, or 5% to some lower equilibrium value. For example, if cabbage packed at 4% moisture is to be dried to a final value of 1.5%, the amount of montmorillonite required will occupy about 6% of the total volume and this much less cabbage can be packed in a given size of container. The corresponding volume occupied by a lime desiccant would be about 2% before expansion. It should be apparent that the fractional volume of desiccant will be proportionately lower, if, as is common in the domestic market, the cabbage is packed without much compression, and hence at a lower bulk density.

DISCUSSION

Figure 1 and Tables 1 and 2 show that dehydrated cabbage can be stabilized to a very substantial degree against nonenzymatic browning during storage at elevated temperature, by in-package desiccation with either lime or montmorillonite. From the results of the triangle test and the soluble color determinations it appears that even the material in Series D, in which the IPD was least effective, had not deteriorated to the point where it would be unacceptable.

The cabbage contained 4300 p.p.m. of SO_2, considerably more than the 1500 to 2500 p.p.m. required by the military specification. However, from the results presented here, together with those of Legault *et al. (7)* for cabbage containing 1080 p.p.m. of SO_2, one might estimate that if 2 oz. of lime or 4 oz. of montmorillonite were used with cabbage of 4.0% moisture, the product would brown in 6 months at 100° F. to roughly the arbitrary limit of palatability as measured by soluble

* Desiccite 25 is described as having a bulk density of 60 lbs. per cu. ft. *(9)*. The bulk density of the cabbage was taken as 13.84 lbs. per cu. ft., corresponding to 1.50 lb. in a No. 10 can or about 10 lbs. in a 5-gallon can. This was a somewhat arbitrary figure, since dehydrated cabbage is compressible, but was chosen on the basis of the military specification requirement that "the greatest commercially practicable quantity" should be packed in a given size of can *(11)*.

color. While this protection should be entirely adequate for normal domestic use, a somewhat greater amount of desiccant might be desirable in military packs to insure high quality even after prolonged storage under unusually severe conditions.

The flavor of sulfite was objectionable to some of the judges and was much more conspicuous when the cabbage was rehydrated cold, as for use in cole slaw, than when it was served cooked. In-package desiccation would permit the use of a lower level of sulfite than is now specified *(6)*, which would make the product more palatable for salad use.

A 30-day period at room temperature before the samples of Series B-E were placed at 100° F. undoubtedly increased the effectiveness of IPD by permitting partial drying at a temperature unfavorable to browning. Hendel and Legault *(4)* have shown that the rate of browning increases more rapidly with a rise in temperature than does the rate of desiccation. Table 1 shows that the soluble color of these samples increased slightly even during the month at room temperature. The data in Figure 2 show that a small but detectable amount of moisture was produced, presumably as a product of the browning reaction, in the moisture-equilibrium samples placed immediately at 100° F., even in the presence of large amounts of desiccant. These results indicate that in any military or commercial application of IPD some control over the temperatures to be encountered by the product during a period immediately after packaging may be desirable. Satisfactory time-temperature schedules would have to be determined.

The effect of IPD on deteriorative reactions other than nonenzymatic browning have not been considered in this study. Accelerated loss of color from dehydrated sweetpotatoes packed in air with a desiccant has been reported *(6)*. With some products packing in vacuum or inert gas may be necessary to prevent oxidative changes of this type. Dehydrated cabbage for military use is packed in nitrogen or carbon dioxide *(11)* but this is not ordinarily done in present commercial practice.

As expected, montmorillonite was found to be substantially less efficient than lime where cabbage must be desiccated to a very low moisture content, but in some cases its use might prove feasible. The ultimate choice of a desiccant must be based on cost, availability, and other factors, as well as on efficiency.

SUMMARY

Montmorillonite was found to be an effective in-package desiccant for dehydrated cabbage. While somewhat less efficient than the preferred desiccant, active calcium oxide, 6 oz. reduced the moisture content of nearly 1½ lb. of cabbage from 4.3% to 1.7% in a No. 10 can. After a 30-day conditioning period at room temperature and 6 months' storage at 100° F. (37.8° C.), the cabbage had browned about one-twentieth as much as corresponding material without in-package desiccation. This amount of montmorillonite occupied 6% of the volume of the can.

The equilibrium moisture relationship between montmorillonite and cabbage in the low moisture range was determined. Curves are given from which can be estimated the relative volume of montmorillonite needed to desiccate cabbage from its moisture content when packed to a given lower value.

A new rehydration test for dehydrated cabbage is described which has the advantage of good reproducibility.

A commercial paper product was found to have promise for use as the container for lime or other desiccant. It is permeable to water vapor, stretches as lime expands during hydration, and can be fabricated into bags on automatic machinery. Such bags should be substantially less expensive than the type now required by the military specification.

Acknowledgments

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Our Daily Bread[a]

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Several months ago I was accorded the opportunity of reading a copy of one of our national metropolitan newspapers printed in the year 1845. The weather, according to the editor, was fair but not too promising. Good farm land in the midwest could be purchased for about forty-two cents an acre. Steaks were costing from twelve to fifteen cents a pound. The socially correct recreational activity for proper young men and young ladies was the exciting pastime of croquet on the front lawn. The more prosperous families were buying the latest horse drawn carriage, the two-seated surrey, with brilliant green upholstering and gay yellow fringe hanging from the roof. As an added innovation the manufacturers now boasted a set of steps on hinges which could be lowered very close to the ground to accommodate the ladies; for society ruled that a lady's dress and her many petticoats must not hang more than one inch from the ground. Outlined with a black border was the announcement that a complete funeral could be secured for twenty dollars, including the paid mourners.

All of these historic facts form an interesting picture of life in another day, far different from conditions in 1954. Our research and our inventions have released a whole new machine civilization. Water, steam, and finally electrical power have evolved a new type of living entirely dependent upon buttons, gadgets, switches, and the throttle. Men have in this century looked through countless microscopes and revealed truths about invisible realms within our physical world. They have carefully studied the process of germs, whose activities destroy the human body, and thus unlocked the secret of successfully combatting some of mankind's deadliest diseases. And now that the mind of man has discovered the method of harnessing atomic energy it is impossible to even predict what developments await us in the future.

"OUR INTELLIGENCE HAS OUTRUN OUR GOODNESS"

The telescope, the test tube and microscope are all very important symbols of the advance and achievement of our materialistic civilization. But with all of their great resultant discoveries they have not brought to the life of the world a full satisfaction of these deeper qualities for which all men hunger—security from want, human freedom, and abiding peace. Perhaps E. Stanley Jones is right when he says, "Our intelligence has outrun our goodness." We have more power than we have character to handle that power. There are those in our society today who suggest that we call a moratorium on invention and discovery until human character has caught up with intelligence.

In our thoughtful moments we must admit that in spite of all of its problems and difficulties this is indeed a challenging and wonderful time in which to be alive. Lewis Mumford was not far from wrong when he claimed that these last fifty years of history have been more significant than the previous thousand years. So widespread, so amazing and baffling have been the changes wrought in these last two generations that, keeping up with life's gadgets, we have often lost sight of the basic fundamentals which give to human existence —depth and meaning—purpose and life.

Through the passing ages much of the equipment of living has changed but the basic drives of human existence have in essence retained their same outline and pattern; the motivating demands for food, shelter, and companionship. The constant pressure of seeking daily bread is as great a challenge in this twentieth century as in any period in the annals of human existence.

Part of an old legend relates the story of a very religious man and his three sons. One day the great creator of the universe, assuming the human form of man, walked into the fields where the brothers were harvesting the wheat. When asked by the stranger what they were doing, the first replied, "I am working for my daily bread." The second said, "Can you not see that I am cutting wheat?" The third brother answered, "I am preparing food for the body, energy for the mind and strength for the soul from that which has been provided by the Creator of the universe."

The answer of the first brother is indicative of the exprience of much of mankind; working for physical daily bread, no more, no less. To such it is a serious business, a matter of grim necessity. At home are mouths to be fed, and the job of earning bread daily is not a choice but a survival demand.

Nor are the peoples of the world who live in this abundant, creative twentieth century entirely ignorant of the pressure and the meaning and the importance of the phrase, "daily bread." I have seen entire families living in dank, dark caves of Southern France existing on boiled roots of trees or whatever could be gleaned from the hillsides. I have seen little children, their emaciated naked bodies bearing the cruel marks of many periods of hunger, fighting like the animals of the woods for the possession of a single morsel of food. The every energy and thought of their waking hour directed toward the one driving motive of securing their "daily bread."

Hunger is one of the chief foes to the establishment of world peace and abundant life for all mankind. Today about seventy percent of the world's people live on a diet below that which is recognized as a minimum standard for man's existence. To raise this diet to the average, which is in itself well below the level of that maintained in the best fed countries, would require as much food as North America and Oceania together produced during the years 1952 and 1953. These facts strikingly emphasize the extent of the world's food problem, the magnitude of which is not understood or

[a] Presented at the General Session, Fourteenth Annual Meeting of the Institute of Food Technologists, Los Angeles, California, June 28, 1954.

appreciated by most of us who are surrounded with plenty.

In spite of the tremendous and commendable movements in the world today dedicated to the task of increasing the supply of food, according to the report of the Food and Agricultural Organization of the United Nations, production is not advancing as rapidly as the population. From this report I quote, "Most of those people who were hungry in pre-war years are now even hungrier. . . . Production in most of the undernourished areas is failing to keep pace with population growth."

Surrounded with plenty we are often apt to be blind to the need of others—failing to realize that the gaunt spector of hunger stalks across most of the world today. Living in the midst of plenty we are also prone to fail in the recognition of our own dependence, believing ourselves to be self-sufficient. In such a frame of mind we adopt the attitude of the rich man in the old parable who said to himself, "I have goods laid up for many years, now my soul can take its ease; eat, drink and be merry." We often speak of man as being independent. And I always wonder, independent of what? It is not simply that plenty has a strange faculty of taking unto itself wings and disappearing. It is not, too, that life is full of instances of tragic uncertainties. But even assuming that plenty, when achieved, can be retained—of what is man independent?

He is not independent of the productivity of the soil, or the change of the seasons, or of imminent death. No man could partake of his daily bread except for the fruitfulness and the faithfulness of nature, over which he can exercise only the remotest control. The realistic fact is that mankind lives in a vast *giveness*. We are all hopeless debtors to the plan and the order and the generosity of a Supreme Creator.

All wealth, in the last analysis, depends upon the produce of the soil. In these days when our civilization is so complicated and complex, this is a fact which we are in danger of overlooking and forgetting. But it is a truth nonetheless. All of the achievements and wealth of the world depend ultimately upon the produce of the soil; upon the simple necessities of everyday existence.

Our monetary system is only valuable for what it can buy, its power of purchasing what is needful for the support of life. Try to imagine our condition of life if a year would pass when the earth did not yield its bountiful increase; that a summer would expire without a crop, without a harvest of corn, of wheat or of fruit; that the world would suddenly find itself without any food. O what use then would be our monetary wealth?

In the last resort, all peoples depend upon the produce of the soil; and the harvest of the fields is the gift of the Creator. With all of his ingenuity and skill man cannot make food. He cannot create bread, in the true sense of the term. With all of our knowledge of chemistry we cannot command a harvest. This comes from a power beyond our ability to control.

I have been told that when the month of August arrives the world is each year within a few weeks of famine. At this particular time the world's granaries contain a relatively limited supply of corn. How forcibly such a fact declares the truth of our dependence!

"BACK OF THE LOAF . . ."

In my early youth I learned the following lines:

Back of the loaf is the snowy flour,
And back of the flour is the mill,
And back of the mill is the wheat and the shower,
And the sun and the great Creator's will.

"Our daily bread" is a factor of living which has meaning and consequence for all of us. And the first brother realized the importance of securing that daily bread in order that physical wants might be satisfied.

But the person who answers only that he is working to fulfill the wants of physical bread has forgotten the vital truth that man does not live by bread alone; that a very significant part of our living is nourished by the mental and spiritual bread of life. And this fact was recognized by the third son who was preparing food for the body, mind, and the soul. Those who rely only on the physical satisfactions have forgotten life's fundamental; that man lives too by thinking, by faith, by worship, by rest, and a hundred other intangible qualities which material possession in and by itself can never attain.

I believe there is a definite correlation between hunger and the advance of totalitarianism. When men and women are suffering from malnutrition they are easy prey to the false promises of an utopian existence. I have lived in countries existing under the cruel heel of the dictator. I have watched the totalitarian regime warp the mind and stifle the high aspiration of the soul. The rule of complete subjection, domination and uniformity of the whole of life—mind, body, and spirit—is absolutely essential to the maintenance of such a philosophy. The free expression of the mind is heresy. Worship of God cannot be tolerated because this constitutes recognition of an authority higher than the state, which in its rule and in its life must be given obeisance as supreme.

Some time ago a newspaper printed a series of pictures portraying the relative size of the earth through the years in terms of the amount of time it required to travel between various points on the globe. The world of Columbus' day occupied half of the sheet. By means of the advance of commerce, transportation and communication the relative size diminished through succeeding periods until the size of the world in the middle of the twentieth century represented the dimensions of the head of a pin. Any point in the world is now less than forty hours by air from the door of your home. Our back yards have expanded. And thus it is important to us today—to our own welfare—what happens to the farmer in Argentina, the coolie in China, the outcaste in India. It is important to us what the Egyptian is being taught, what the Malayan is thinking. Our neighborhood is no longer just the community in which we live, it is the whole world. We find ourselves challenged with the necessity of learning to know our neighbors—our neighbors of varying cultural backgrounds; of different creeds and many hued colors—and sharing in their needs and in their hungers. What affects them has a direct bearing on our own welfare and on our own way of life for we are all bound together in a common destiny.

As men and women of a free and democratic way of life, desirous of seeing that way propagated for the blessing of our children and our children's children, our greatest weapon against the totalitarian philosophy is to demonstrate to the world the vitality and good faith of the cause of freedom, not by false promises but by actual deeds through the production and distribution of food, the encouragement of a free, truth-seeking mind, and the unrestricted worship of God according to the dictates of individual conscience.

As men of science and men of religion we share in the common challenge of seeking sufficient "daily bread" to nourish the needs of mankind—physical, mental, and spiritual.

The Slide Plate Method of Estimating the Number of Viable Microorganisms in Orange Juice[a]

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(Manuscript received March 26, 1954)

The slide plate method—a modification of Frost's little plate procedure—utilizes ordinary bacteriological equipment to obtain bacterial and yeast counts in orange juice after an incubation period of seven hours. Counts obtained by the slide plate method compare favorably with counts obtained by the standard plate procedure.

For over fifty years the plate count method has been used in bacteriological analysis of milk and water. Various modifications *(4)* have been suggested for reducing the time required in reading the results. Despite these many changes, the plate count method has remained the standard procedure and final reference. The standard plate count method has customarily been used for bacteriological quality control in the orange products industry. However, a more rapid method would be desirable, particularly in processing frozen concentrated orange juice.

In Florida a direct microscopic method, which uses a modification of North's Methylene Blue Milk Stain *(3)*, has been developed. Although there is poor correlation between the direct count and the plate count methods, the direct method has been useful to estimate the microbial population of the juice in the low-temperature evaporators *(2)*. When plate counts and direct counts are done on the same sample, the direct count is normally much higher. The reason for this might be that organisms which were dead at the time of sampling were counted along with those that were living. Other organisms which also may be counted are those that are unable to multiply in orange juice and are therefore of little practical importance; e.g., soil bacteria such as members of the genus *Azotobacter* which fail to reproduce at the pH normally found in orange juice.

Estabrooks and Bollen *(1)* have described a microplating technique which might be adapted to orange juice. A 0.05 ml. amount of sample is mixed with 3 drops of culture medium on a glass slide. After 10 hours incubation in a moist chamber the colonies that develop in the entire preparation are counted with a wide-field microscope using 10× magnification.

Prior to the publication of Estabrooks and Bollen's technique, the author, in searching for a method to use for orange juice analysis, found Frost's little plate method for milk to offer the best possibilities for reducing the time of incubation, and at the same time to yield results comparable to the standard plate count. Some variation of Frost's system was considered necessary before it could be adapted to orange juice, because the pulp particles normally present either plugged or made inaccurate the use of capillary pipettes for measuring the sample. A modification of Frost's procedure termed the "slide plate method" was developed.

Counts are obtained in 7 hours with this method, using bacteriological (one-ml.) instead of capillary pipettes. The slide plate method is easier to use than Frost's, although it is slightly more complicated than the standard plate count method or the microplating method of Estabrooks and Bollen. On the other hand, the slide plate method is believed to possess a greater degree of accuracy than earlier micromethods, because larger, more accurately measured quantities of sample and medium are employed.

EXPERIMENTAL

The apparatus and materials recommended for the slide plate method are as follows:

Microscope: AO Spencer stereoscopic microscope, or equivalent, with mechanical stage.

Microscope slides: Precision grade, frosted end, size 7.55 cm. x 2.55 cm., thickness 0.105 to 0.115 cm.

Cover glasses: Square, precision grade No. 2, size 18 mm.

Forceps: Cover glass or specimen pinning, over all length 115 mm.

Spatula: Stainless steel, length of blade 100 mm.

Pipettes: Bacteriological A. P. H. A., delivers 1 ml.

Culture tubes: Screw cap, length 125 mm., outside dia. 20 mm.

Culture dishes: Bacteriological, petri, "Pyrex" brand, outside lid dia. size 100 mm.

Heater: Infra-red (Fisher).

Fan: Household type, blade 35 cm.

Incubator: Bacteriological, temp. setting 30° C.

Staining jars: Coplin.

Culture medium: Orange serum agar pH 5.80, in screw cap culture tubes, 13.8 ml./tube.

[a] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, July 1, 1954.

Plain agar: Sterile agar (12 g./l.), 150 ml./flask.

Stain: Loeffler's Methylene Blue.

Alkaline rinse water: Tap water with sufficient KOH added to adjust the pH to about 11.

PROCEDURE

Pour 12 to 14 ml. of sterile agar into a sterile petri dish placed on a level surface and allow the agar to set. The petri dishes selected should have an inside diameter of 90 mm. Using sterile forceps, carefully place a cool microscope slide, which has been sterilized either by flame or in an oven, on the surface of the agar within the petri dish. The slide normally adheres, but it may be necessary to press lightly with the forceps on the surface of the slide to obtain good adherence. Petri dishes thus prepared are termed "prepared plates" and are ordinarily made one day before being used. To store these plates, invert and keep at room temperature.

When a sample of orange juice is to be plated, melt a tube of orange serum agar and cool to 48° Centigrade.[b] The medium should be put up in screw cap culture tubes (13.8 ml./tube) so that after sterilization and cooling to 48° C., 13.0 ± 0.2 ml. can be poured from each tube into a "prepared plate." Next dilute the orange juice sample with sterile distilled water (1:5 for single strength juice, 1:10 for 58° Brix juice) and shake thoroughly. Transfer one ml. from the dilution tube into the tube of melted orange serum agar. Invert the tube gently 25 times before pouring the contents into a "prepared plate," in order to establish an even layer of uniformly inoculated orange serum agar on the surface of the glass slide. It is very important that the temperature of the orange serum agar be in the range from 46° to 48° C. at the time the inoculum is added and that the plate be level and not disturbed until the agar has set. After the agar has set, invert the plate and incubate at 30° C. for 7 hours (Figure 1).

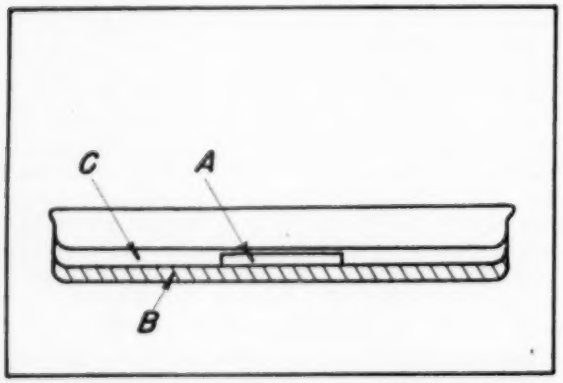

Figure 1. Diagram of an inoculated slide plate without cover: (A) glass slide; (B) plain agar; (C) inoculated orange serum agar.

At the end of the incubation period cut with the spatula around the embedded slide and remove the slide from the dish. The slide will have on its surface a layer of orange serum agar containing minute colonies. Trim the layer with a spatula to an area of approximately 2.5 x 2.5 cm. and dry the agar film on the slide. The agar film can be dried quickly with minimum distortion by using an infrared lamp held about 5 cm. above the slide. A household fan allowed to blow on the slide while it is drying, lessens the drying time and prevents the film from charring. Without the fan the agar film, once it is dry, will char quickly unless removed immediately from the source of heat. After the film is dry (about 8 min.), allow the slide to cool and then immerse it for 25 to 30 sec. in Loeffler's Methylene Blue Stain.[c] Remove the slide from the stain, dip the slide 5 to 10 times in the alkaline rinse water, and apply a cover glass, using the alkaline rinse water for mounting. Blot off the excess water and the preparation is ready to be examined under the microscope. The colonies appear dark-blue against a light-blue background and are readily differentiated from other materials by color and outline.

In routine work, 2 to 5 minutes are required to examine the slide. Only the colonies in about ½ to 1/10th of the total preparation need be counted, depending upon whether the count is low or high. A net reticule in the eye piece of the microscope greatly facilitates the counting. A factor is necessary to convert the count to colonies developing per ml. of samples. This factor may be obtained by the following formula:

$$(1)\ \frac{\text{area examined x the depth of the orange serum agar layer before drying}}{\text{dilution of the sample with water and with the orange serum agar}}$$

This formula yields the amount of juice actually examined and the factor is simply the reciprocal of this number.

The use of this formula is illustrated by the following example:

The area examined was 10 microscopic fields, each having a measured area of 0.109 sq. cm. as determined by using a micrometer disc. Therefore the total area examined was 1.09 sq. cm.

Inside dia. of the petri dish was 9.0 cm.

Volume of the slide was 2.018 cc.

Volume of the poured orange serum agar plus the inoculum was 14 cc.

Height of orange juice serum agar layer above the plain agar was $h = V/a$ or $h = 16/4.5^2 \times \pi$ or $h = 0.252$ cm.

Then the depth of the orange serum agar layer before drying on the slide was 0.252 minus the thickness of the slide or 0.142 cm.

Single strength juice was used, therefore it was first diluted with water 1:5, and this was diluted 1:14.8 with the orange serum agar or a total dilution of 1:74.

Substituting these values in formula (1):

$$\frac{1.09 \times 0.142}{74} = 0.002 \text{ cc.}$$

The factor is then $\frac{1}{0.002}$ or 500

Because of the unavoidable variations in the size of slides, diameter of the petri dishes, and in the volume of the orange serum agar poured, this factor was estimated to be accurate to about ± 5%.

RESULTS

In this Laboratory satisfactory agreement between the slide plate and the plate count methods was obtained when several hundred samples of single strength and concentrated orange juice were plated. Typical data from these tests are included in Table 1. Uniformity was sought in these tests by using the same batch of dehydrated orange serum agar in both methods and by using duplicate slides and plates for each sample.

DISCUSSION

The colonies were counted using a wide-field microscope (27× magnification). A compound microscope using 80× magnification was also used successfully. Nevertheless, the wide-field microscope made it possible

[b] The dehydrated orange serum agar prepared by J. W. Stevens, Sunkist Growers, Research Department, was used in the experiments on which this paper is based.

[c] The stain consists of 30 ml. saturated alcoholic solution of methylene blue mixed with 100 ml. of a 1:10,000 aqueous solution of KOH.

TABLE 1

Typical data comparing plate counts to slide plate counts on thirty samples of orange juice.

Sample number	Plate count [1]	Slide plate count [2]
1	38,000	51,000
2	105,000	100,000
3	36,000	49,000
4	31,000	34,000
5	87,000	95,000
6	43,000	16,000
7	72,000	64,000
8	70,000	96,000
9	42,000	76,000
10	290,000	375,000
11	30,000	17,000
12	42,000	34,000
13	84,000	86,000
14	190,000	250,000
15	37,000	26,000
16	300,000	300,000
17	62,000	40,000
18	105,000	71,000
19	300,000	290,000
20	56,000	76,000
21	60,000	110,000
22	60,000	83,000
23	84,000	57,000
24	34,000	21,000
25	81,000	130,000
26	35,000	31,000
27	100,000	150,000
28	30,000	22,000
29	96,000	100,000
30	110,000	135,000

[1] Plate counts were determined after 48 hr. incubation at 30° C. using orange serum agar pH 5.45.

[2] Slide plate counts were determined after 7 hr. incubation at 30° C. using orange serum agar with final pH after adding the inoculum from 5.40 to 5.60. Counts are reported as colonies developing per ml. of sample.

to examine rapidly a larger area of the slide, thereby increasing the accuracy without increasing the time or effort of counting.

The orange serum agar of pH 5.45 was found to be altered significantly by adding 0.1 ml. of 58° Brix orange juice or 0.2 ml. of single strength juice to 13.8 ml. of the agar. In order to keep the final pH within the desired range of 5.40 to 5.60 the orange serum agar put up in tubes for the slide plate method was adjusted to a pH of 5.80 ± 0.05. This made possible a final pH range of 5.40 to 5.60 after the inoculum was added.

Comparatively low counts were sometimes obtained with the slide plate method. When this occurred, a careful study of the standard plates revealed a high percentage of "pin point" colonies. These colonies were composed of a slow-growing bacterium which failed to produce colonies detectable on the slide plates even when the incubation time was increased to 10 hours. Catalase tests performed with these bacteria were positive, which indicated they were neither lactobacilli nor leuconostoc.

Samples of orange juice which had been frozen or held for several hours at 8° C. often showed a lower slide plate count than the standard plate counts. Ten hours' incubation of such samples usually brought good agreement between the two methods. "Spoilage-type" bacteria; e.g., *Lactobacillus plantarum* and *Leuconostoc mesenteroides*, growing at the time of sampling developed colonies rapidly. It was not uncommon to be able to count them after an incubation period of 5 hours.

A noteworthy advantage of the slide plate method over the standard plate method is that one dilution of the sample is adequate for counts ranging from 10,000 to 10,000,000/ml. Other advantages are these: surface and subsurface spreaders do not develop in the 7 hr. incubation period and the slides provide a permanent record for several months.

SUMMARY

For rapid estimation of microorganisms in orange juice, the slide plate method was found advantageous over the standard plate count method because (a) counts can be obtained after 7 hours incubation instead of 48, (b) spreaders do not confuse the count, (c) one dilution of the sample is adequate for counts ranging from 10,000 to 10,000,000/ml. (d) the slides provide a permanent record for several months.

Acknowledgment

The author wishes to express his appreciation to J. W. Stevens, Research Department, Sunkist Growers, for his helpful suggestions and encouragement.

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Mandatory Standards Program on Quality Factors for Frozen Asparagus and Peas—An Industry Approach. I. Purpose and Organization of Program[a]

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(Manuscript received May 29, 1954)

Standards for frozen foods are reviewed with emphasis on mandatory standards promulgated by the Food and Drug Administration. Organization of the industry's program of research on the evaluation of objective tests for measuring off-flavor and texture of frozen asparagus and peas, which when correlated with organoleptic scores assigned by experienced taste panels predicts standard-substandard breakpoints, is presented.

There are three types of standards for evaluating the quality factors of grades for frozen foods. Packer's standards and those of the United States Department of Agriculture define upper and lower limits for each of several factors that go to make-up the respective grades within a given standard for a specific frozen food, while standards of the Food and Drug Administration define the composition of the product, fill requirements, and the limiting quality for that product.

Packers of frozen foods operate under self-imposed standards developed through years of experience in harvesting and quick-freezing fruits, juices, and vegetables. Specifications of *Fancy*, or *Grade A*, call for the very best in tenderness, flavor, and color. *Extra Standard*, or *Grade B*, includes good tenderness, flavor, and color. Product with average tenderness, flavor, and color is graded *Standard*, or *Grade C*.

Some thirty-five standards have been issued by the United States Department of Agriculture for the optional use of all segments of the frozen food industry. These standards fulfill an important service by supplying a quick and ready means of determining loan and sale values.

The Secretary of the Department of Health, Education, and Welfare has the authority to promulgate regulations fixing and establishing for most processed foods a reasonable definition and standard of identity, a reasonable minimum standard of quality, and/or reasonable minimum standards of fill of container. Standards of identity establish the composition of the food and provide for accurate and adequate informative labeling. Standards of quality define the limiting quality beyond which the product is considered to be inferior and is subject to seizure when shipped in interstate commerce unless it bears a substandard label. Standards for fill of container provide for minimum amount of unavoidable headspace and interstices occupied by other than product when packed in a given type of container.

Standards of identity, quality, and fill of container are mandatory. They have the effect of law; in consequence, they must be complied with by food processors. This is the most significant difference between Food and Drug Standards and those that are self-imposed by the packers, or those that are provided by the United States Department of Agriculture for the optional use of interested parties.

INSTITUTION OF PROGRAM

The mandatory standards-making process formerly required considerable expenditure of resources and time. It began when the Secretary, formerly the Adminisrator of the Federal Security Agency, notified an industry that he believed it to be in the best interests of consumers that standards be developed for one or more products of that industry, or when a substantial portion of the industry requested a hearing. In 1949 the frozen food industry was advised that the Food and Drug Administration was contemplating the development of standards of identity and quality for frozen asparagus and peas. The Board of Directors of the National Association of Frozen Food Packers immediately authorized the Research and Standards Committee to institute and carry out a program of research with the specific purpose of developing adequate and reliable information on all factors that might possibly be included in the contemplated standards. The institution of the program is shown in Figure 1.

Representatives of the Food and Drug Administration met with the Research and Standards Committee to inform the industry of the Government's reasons for instituting standards-making and to work out a preliminary position on the standards. Under the procedure heretofore required, both the government and the industry were faced with the complex task of compiling evidence for presentation at a public hearing. This evidence would permit the Secretary to make detailed finding of fact as a basis for the proposed standards. Such lengthy procedure and the increasing economic importance of the standards with greater annual packs[b] suggests that more emphasis be placed on the consensus principle for resolving the deep economic and scientific questions that develop *(4)*. Much was accomplished towards realizing a more simplified procedure when Public Law 335 became effective on April 15, 1954. Under the provisions of this law, formal hearings are not required, except upon proposed provisions of the standard, or standards, to which objection is made by persons who would be adversely affected by such provisions.

ENACTMENT OF PROGRAM

Since the contemplated standards of identity for frozen asparagus and peas are concerned with definitions of product and variations, by style, plus optional ingredients, etc., rather than with quality factors, the balance of this paper will be concerned exclusively with the standards of quality. The preliminary industry position was determined by sending a detailed questionnaire to every domestic packer of frozen asparagus and peas to determine industry practices and recommendations on the application and acceptability of:

a. Methods for measuring residual catalase, peroxidase, or other enzymes; and chemical components, such as acetaldehyde, to determine adequacy of blanch during processing and to detect the occurrence of off-flavor;

[a] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, June 29, 1954.

[b] National production of frozen asparagus and peas was 255.4 million pounds in 1953 *(1)*. This amounts to an increase of 220 percent over the production of these products in 1943.

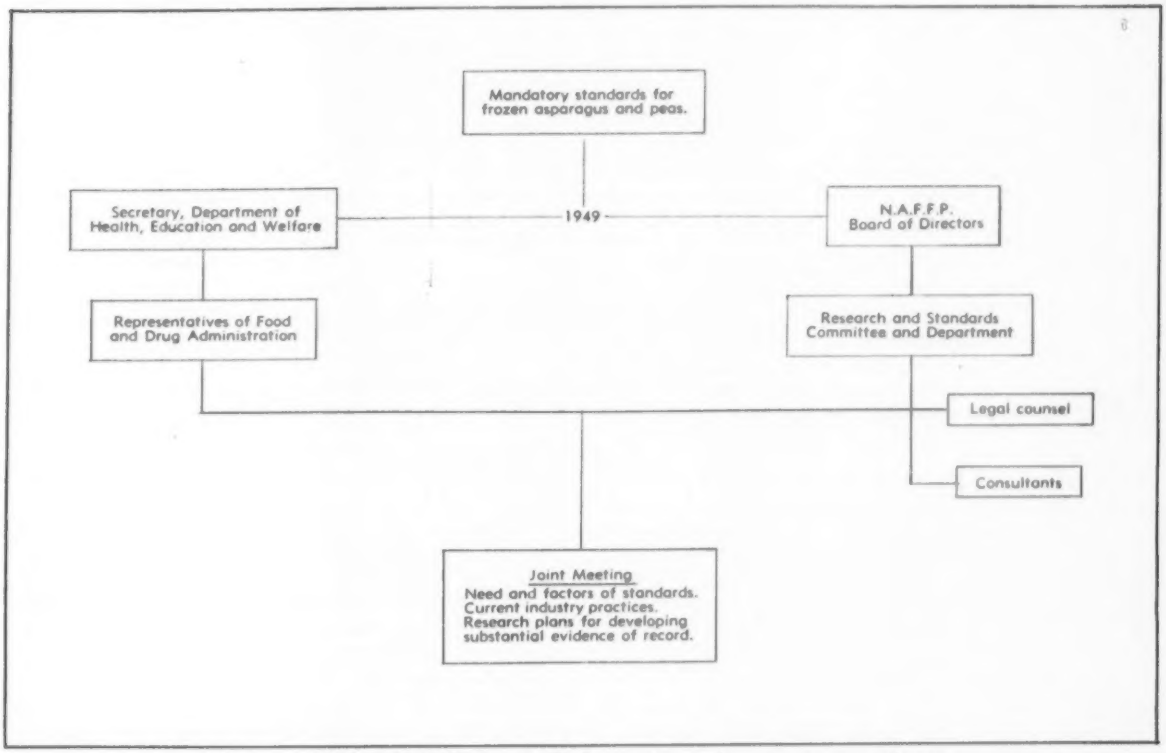
Mandatory standards for frozen asparagus and peas.
1949
Secretary, Department of Health, Education and Welfare
N.A.F.F.P. Board of Directors
Representatives of Food and Drug Administration
Research and Standards Committee and Department
Legal counsel
Consultants
Joint Meeting
Need and factors of standards.
Current industry practices.
Research plans for developing substantial evidence of record.

Figure 1. Institution of mandatory standards program on frozen asparagus and peas.

b. The fibrometer, or other methods, as a means of measuring fibrousness; and whether the presence of flowered and shattered heads; stained, crooked, double, and hollow spears; atypical color; small pieces; or lack of uniformity should require substandard labeling of frozen asparagus; and

c. The Alcohol Insoluble Solids test, brine flotation, crush tests, or any other applicable methods, for accurately measuring the tenderness and maturity of frozen peas; plus rational tolerances for harmless extraneous materials.

Returns indicated strongly that the quality factors of flowered and shattered heads, etc., for asparagus and the presence of harmless extraneous materials in peas be eliminated as a consideration of quality at the standard-substandard level. It was the consensus that provision for these factors within optional standards for grades of these products is sufficient without mandatory standards. Qualitative testing of commercially frozen asparagus and peas indicated that experimental packs of both products would be required to evaluate each of the several objective tests for detecting off-flavor and for establishing a factual standard-substandard maturity which was indeterminate from the questionnaire.

The basic format of research that was effected in developing the industry's position is shown in Figure 2. Three classes of experimental samples were procured through the cooperation of packers in representative areas of production. Each class of samples was packed according to uniform procedures that reflected good commercial packing practices except for the necessary experimental variations. All samples were shipped to the universities cooperating in the program by means of either Church Freight Service and railway express, or by Shamrock shippers and air freight, with special accompanying instructions for replenishing dry ice during transit by both methods.

Enzymatic activity samples. Enzymatic activity samples are the first class of experimental samples on frozen asparagus and peas shown in Figure 2. Each lot consisted of 4 variations on blanching times, as follows: unblanched, half-blanch, normal-blanch, and double-blanch. A lot of samples on both products was packed during the 1950 season in California, New Jersey, and the Oregon-Washington area.

Companion samples from each variation on blanching and area were tested in replicates of six at the Food Technology Department of Oregon State College and at the Horticulture Department of the University of Maryland. Uniform and objective methods were employed for detecting catalase and peroxidase activity and the occurrence of acetaldehyde after 1, 3, 6, and 12 months' storage at 0° F. (—17.8° C.). Concurrently, members of the Research and Standards Committee and other industry technologists met as organoleptic panels in California, Maryland, and Oregon to evaluate the flavor characteristics of each variation in replicates of six. Procedures and results are presented by Wilder and Samuels *(5)*, and Kramer *(2)*.

Fibrous asparagus samples. Kramer, Haut, Scott, and Ide *(3)* found that sizing and classifying freshly harvested asparagus spears according to resistive cutting pressures measured by a modified Baluff instrument provided a good spread of fibrousness. This method

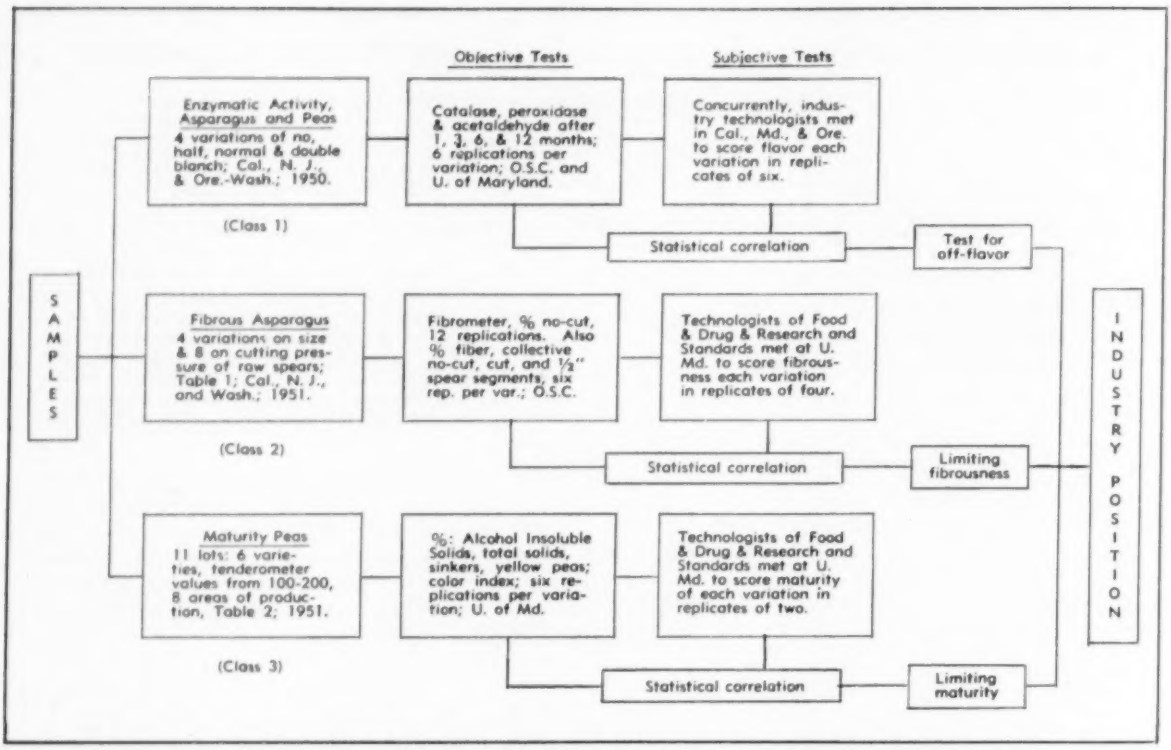
Objective Tests
Subjective Tests
Enzymatic Activity, Asparagus and Peas
4 variations of no, half, normal & double blanch; Cal., N. J., & Ore.-Wash.; 1950.
(Class 1)
Catalase, peroxidase & acetaldehyde after 1, 3, 6, & 12 months; 6 replications per variation; O.S.C. and U. of Maryland.
Concurrently, industry technologists met in Cal., Md., & Ore. to score flavor each variation in replicates of six.
Statistical correlation
Test for off-flavor
SAMPLES
Fibrous Asparagus
4 variations on size & 8 on cutting pressure of raw spears; Table 1; Cal., N. J., and Wash.; 1951.
(Class 2)
Fibrometer, % no-cut, 12 replications. Also % fiber, collective no-cut, cut, and ½" spear segments, six rep. per var.; O.S.C.
Technologists of Food & Drug & Research and Standards met at U. Md. to score fibrousness each variation in replicates of four.
Statistical correlation
Limiting fibrousness
INDUSTRY POSITION
Maturity Peas
11 lots: 6 varieties, tenderometer values from 100-200, 8 areas of production, Table 2; 1951.
(Class 3)
%: Alcohol Insoluble Solids, total solids, sinkers, yellow peas; color index; six replications per variation; U. of Md.
Technologists of Food & Drug & Research and Standards met at U. Md. to score maturity of each variation in replicates of two.
Statistical correlation
Limiting maturity

Figure 2. Basic format for industry research on mandatory standards for frozen asparagus and peas.

was adopted as an objective means of preparing fibrous asparagus samples for use in establishing a fiber level that would characterize the texture breakpoint for substandard frozen asparagus. The experimental fiber ranges for each lot of samples are presented in Table 1.

A lot of asparagus samples was packed in California, New Jersey, and Washington during the 1951 season. Raw material delivered to the docks of the food freezing plants was used in preparing the samples. The asparagus spears were sized into the 4 diameter ranges given in column 2 of Table 1. The sized spears were then classified into the ranges of cutting pressures shown in column 3 of Table 1. The cutting pressure was measured 5 inches from the tip end of each asparagus spear. Some

TABLE 1
Fiber ranges for each lot of fibrous asparagus samples

Sublot	Fiber ranges	
	Spear size	Cutting pressure pounds
a	Small	4 to 8
b	Small	9 to 12
c	Medium	<10 to 11
d	Medium	12 to 15
e	Large	<14
f	Large	14 to 18
g	Extra Large	16 to 20
h	Extra Large	21 or more

Small = less than ⅜"; Medium = ⅜" up to ⅝"
Large = ⅝" up to ⅞"; Extra Large = ⅞" or more.

overlapping of resistive cutting pressure ranges was necessary because of the difficulty encountered in finding sufficient raw material that would fall into more refined ranges. Sufficient raw material was thus prepared to pack-out 24 companion packages for each sublot and region.

The Food Technology Department of Oregon State College was supplied with 12 random packages from each sublot. The fiber content of each package was qualitatively determined by placing cooked spears on the fibrometer and proceeding with cutting attempts at half-inch increments. The same sample material was then used for a quantitative evaluation of fiber content that was replicated 6 times for: (a) collective one-half inch spear segments from a given package; and (b) collective "cut" and "no-cut" spear segments from a given package.

Representatives of the Food and Drug Administration joined the Research and Standards Committee to complete a taste panel that scored the fibrousness of each sublot in replicates of 4 at the University of Maryland. Methodology and results are reported by Wilder and Samuels *(5)*, and Kramer *(2)*.

Maturity pea samples. The purpose of maturity pea samples, the third class shown in Figure 2, was to establish a suitable test for predicting substandard maturity for frozen, sweet peas. Each of 8 cooperating packers set aside about one-third acre of the variety predominant in their area of production. Periodic tenderometer readings were made as the peas began to mature. When readings fell within the range 110 to 120, sufficient peas were harvested to pack out a case of 24 retail packages according to good commercial practices, except that quality grading was purposely omitted to provide for an adequate spread of maturities with successive harvests at increasing tenderometer values. Harvests continued at every 10 units on the tenderometer until samples reflecting the range 200 to 210, had been packed. The 6 varieties, 8 areas of production, and 86

TABLE 2

Tenderometer values for six varieties of peas harvested in eight areas of production

Tenderometer values by variety and area of production										
D.S.P.[1]	Glacier	Shasta	Thomas Laxton						Victory Freezer	Wyola
Wash.	*N. J.*	*N. J.*	*Me.*	*Md.*	*Minn.*	*N. J.*	*N. Y.*	*Ore.*	*N. J.*	*Calif.*
109	129					116		108	118	
113	118		118	116	110	111	113		112	
125	129	121	126	130	122				125	122
131		139	133	139	136	130	134	131	138	137
147	144	147	142	149	142	143	144	142		
156	158	137	155	159	154		153	153	155	151
166	166	151	163		168	164				165
170		175	177	176		174	175	177	177	
188	181	190	185	186	183	186	183		180	
	191	182				190+	195		190	195
	200+	195+			200+			200+	200+	200+

[1] Dark Skinned Perfection.

maturity variations for the 11 lots of samples thus procured are presented in Table 2.

The maturity of each variation was determined by testing packages taken at random from a given sublot. Procedure for the objective tests: Alcohol Insoluble Solids; total solids; quadruplicate tests per package for percent sinkers in 15% and 16% brine, respectively; percent yellow peas, by weight; and color index as calculated from "a" and "b" readings of the Hunter Color and Difference meter; is presented by Wilder and Samuels *(5)*. These tests were completed at the Horticulture Department, University of Maryland. Organoleptic procedure was followed in two replicate evaluations of maturity by the same experienced taste panel that scored the fibrous asparagus samples. Results are presented by Kramer *(2)*.

SUMMARY

The organization and enactment of an industry approach to mandatory standards for frozen asparagus and peas has been presented. The fruition of this program follows in subsequent papers presenting uniform methodology and the statistical correlation of factual results derived from objective and organoleptic testing of experimental samples. A further correlation of these results with industry practice and policy in light of legal principles and requirements will constitute the substantial evidence for the industry's position when the hearings are scheduled.

Acknowledgment

Appreciation is expressed to representatives of the Food and Drug Administration for their helpful counsel and assistance, to the Research and Standards Committee and other industry technologists for their fine cooperation in supplying and scoring experimental samples, and to scientists at Oregon State College and the University of Maryland for their kindness in completing and evaluating the many tests.

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Mandatory Standards Program on Quality Factors for Frozen Asparagus and Peas — An Industry Approach II. Selection of Official Analytical Procedures[a,b]

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It is very important to consider seriously all factors in the selection of methods of analyses in any program undertaken to produce reliable facts for the purpose of measuring quality of food products. Objective methods of evaluating the quality of frozen asparagus and peas were studied independently by representatives of the Food and Drug Administration and the Research and Standards Committee of the National Association of Frozen Food Packers with consultations between the two groups from time to time. The following analytical procedures were used in this program on quality factors for frozen asparagus and peas.

1. **Enzymatic activity samples.** *Unblanched, half-blanched, normally blanched and double-blanched frozen asparagus and peas after 0, 1, 3, 6, and 12 months storage at 0° F. (−17.8° C.).*

[a] Approved for publication as Research Report No. 3 by the Director of the Oregon Agricultural Experiment Station. Contribution of the department of Food Technology.

[b] The title of this paper should not be interpreted to mean that the methods studied in this program are "official" in the legal sense. The term *official* is used to connote *authoritative*.

1. Acetaldehyde

A 50 g. sample was prepared from frozen product material by rapidly grinding through a common, kitchen meat grinder. The ground material was washed into a 500 ml., standard taper Kjeldahl flask with 150 ml. of distilled water and 1 to 2 drops of the "DC Antifoam A" were added for steam distillation into a 500 ml. Erlenmeyer flask containing 100 ml. of freshly boiled distilled water and weighted down with a lead ring in an ice bath to prevent vaporation losses. Brisk distillation followed such that 200 ml. of distillate passed to the receiving flask within 15 minutes. After removing the Erlenmeyer flask from the ice bath, 35 ml. of aldehyde free ethanol and 25 ml. of 0.05 N sodium bisulfite in 10% ethanol were added. The flask was permitted to stand for exactly 30 minutes with occasional shaking. Then, 25 ml. of 0.05 N iodine were added and the solution was titrated with 0.05 N sodium thiosulfate using 5 ml. of 1% starch solution as indicator. A blank determination followed using 300 ml. of distilled water in place of the vegetable distillate. The quantity of acetaldehyde was calculated as the product of 1.1 × the difference in volume of sodium thiosulfate used for the test sample and for the blank. Acetaldehyde was converted to parts per million by multiplying mg. × 20. Standardized solutions were prepared by A.O.A.C. methods *(4)*.

2. Quantitative Catalase

This precedure is reported in the *Journal of the Association of Official Agricultural Chemists (2)* and is a titrimetric method where the catalase content of a sample may be accurately determined in terms of K_t which is an expression of the catalase content or purity of the preparation. The analysis is a measure of the activity of catalase reacting with hydrogen peroxide against time.

3. Semi-quantitative Catalase. Gas Method

This is an adaptation of the Thompson apparatus *(6)* in which a measurement is made of the amount of gas given off in unit time as a result of mixing a filtrate of a vegetable sample with a designated amount of hydrogen peroxide.

4. Qualitative Catalase

An equal weight of sample (25 g.) and distilled water was ground with sand in a mortar and pestle. The mixture was decanted into a fermentation tube containing 18 ml. of distilled water and 1 ml. of 0.5% H_2O_2 (made fresh daily). The tube was shaken and the arm closed by inverting the tube. The sample was observed in 2 minutes for evidence of gas evolution. The amount of gas present was rated from trace to positive. A system is contemplated involving a graduated tube so that gas volume may be given in terms of milliliters. The qualitative test, here presented, has been checked against the quantitative catalase test on over 400 samples; the agreement was very good.

5. Quantitative Peroxidase

This is the method of Lucas and Bailey *(3)*. Solutions were prepared by the recommended procedures. A 25 g. sample was prepared from frozen product material by disintegrating in a Waring blender with approximately 1 g. (knife point) of C.P. precipitated calcium carbonate and exactly 500 ml. of distilled water. The blender was operated exactly 3 minutes. The disintegrated material was filtered through 4 thicknesses of cheese cloth into a beaker. It was refiltered by carefully decanting into a funnel containing 4 thicknesses of cheese cloth. (Two filtrations through cheese cloth required less time and yielded more filtrate than one filtration through paper.) One ml. of the second filtrate was pipetted into a 25 ml. Erlenmeyer flask, and 1 ml. of d-isoascorbic acid solution and 3 ml. of dye solution were added by pipette. The flask was shaken and transferred to a constant temperature water bath at 25° C. The Erlenmeyer flask was swirled in the water bath for exactly 1 minute, (stopwatch), removed from the bath and 0.5 ml. of 0.3% hydrogen peroxide solution was added by pipette and simultaneously a stopwatch was started. The Erlenmeyer flask was shaken and immediately placed back into the constant temperature water bath. Just before a minute expired the flask was removed from the water bath and precisely one minute after starting the stopwatch 1 ml. of inhibiting acid solution was added and the flask shaken vigorously. The solution was titrated against the dye solution until a permanent pink color appeared. The end point indicated the oxidation of the excess of the d-isoascorbic acid which had remained in the solution after the reaction was inhibited. The peroxidase activity was expressed in terms of P.V. (peroxidase value), which was the number of mg. of d-isoascorbic acid oxidized within 1 minute in 1 g. of enzyme containing substance at 25° C.

6. Qualitative Peroxidase

A 5 g. sample was taken as for the qualitative catalase test and ground with 5 ml. of distilled water and a small amount of acid washed sand. The mixture was decanted into a 1-inch diameter test tube. One ml. of 0.5% hydrogen peroxide and 1 ml. of 1% alcoholic guaiacol were added. The mixture was shaken and allowed to stand 5 minutes. Evidence of peroxidase activity was the production of a reddish-brown coloration. The depth and extent of this color was recorded from trace to slight to positive.

II. Fibrous asparagus spears. *Prepared from normal raw material in three areas of production.*

1. Texture

The asparagus lots were divided into groups of 12 replicate samples (packages). All of the samples, within a "group" were cooked at Atmospheric Pressure (Normal Cook) by using that volume of 1% NaCl solution that insured complete coverage of the product. The same volume was used when a series of samples of the same class were cooked. The 1% salt solution was brought to boiling, the frozen product added, heat continued until second boil started and then boiled for 10 minutes. After the cooked sample had cooled to room temperature, the fibrometer tests were made using a National Canners Association Fibrometer, which exerts a cutting pressure of 3 pounds. Starting ½" from the butt end and proceeding towards the tip, attempts were made to cut the spear at each successive ½" increment of spear length. The cutting wire was not forced. An "N" was recorded if there was no cut and a "Y" if a cut occurred. Every spear present in the entire sample was thus tested.

For each sample in each of 6 groups of the 12 original groups 10 beakers marked 1-10 were arranged and successive ½" segments from each spear present in the sample were collected. A knife was used to sever those segments which were not cut by the Fibrometer. (Contents of these beakers were analyzed later for fiber by the Alkaline Digestion Method.) For each sample in each of the remaining 6 groups of the 12 original groups all of the following were collected: "No Cut" segments from the entire sample in a marked beaker by severing the asparagus spear at the last "N" encountered and at each "No Cut" interval encountered; "Cut" segments from the entire sample in another beaker. (Contents of these beakers were analyzed later for fiber by the Alkaline Digestion Method.) The percent of "No Cuts" per spear and the percent "No Cuts" per interval-sample were recorded.

2. Percent Fiber. Alkaline Digestion Method

The beaker of asparagus segments was emptied into a flat bottom pan (approximately 8 to 9 inches bottom diameter) and approximately 600 ml. of water at room temperature was added. The pan was agitated gently in a circular motion for 30 seconds and the water decanted. This was repeated and then the sample was drained for 2 minutes on an 8-inch, No. 8-mesh woven wire cloth sieve. The sample was weighed and then transferred to a metal cup of a malted milk stirrer; the procedure used was that prescribed in the Standard of Quality for canned green beans *(5)*.

III. Maturity peas. *Six varieties of peas harvested in eight areas of production at tenderometer values from 108 to beyond 200.*

1. Percent Yellow Peas, by Count

Yellow peas were separated from all peas within a given package, counted, weighed, and recorded as percent by weight of the net weight.

2. Brine Flotation Test

Sodium chloride solutions of 15% and 16%, by weight, were prepared and permitted to equilibrate to room temperature. Sufficient 15% NaCl solution was added to a 250 ml. beaker to achieve a depth of 2 inches, and the same amount of 16% NaCl solution was added to another beaker. The 12-ounce sample was defrosted in an evacuated, sealed, flexible, moisture proof bag in either a stream of moving air at 80-85° F. (26.7-29.4° C.) for 2½ hours, or in a water bath at 68° F. (20° C.) for 2 hours. The defrosted peas were spread evenly throughout a shallow white pan which had been subdivided into quarters A, B, C, and D by marking in lines. The peas were permitted to equilibrate to room temperature, and at random, 40 peas were removed from quarter A of the shallow white pan. Twenty of these peas were peeled and placed in the beaker containing 15% brine solution and after exactly 10 seconds the number of peas which had sunk to the bottom of the beaker within this time period was counted. When cotyledons of peas became separated, two of the separated cotyledons were considered as one pea; and if an odd cotyledon had sunk it was counted as one pea. The remaining 20 peas were peeled and the test repeated using the 16% NaCl solution. Using fresh brine solutions in each case, the above tests were repeated on quarters B, C, and D of the white pan. The average percent sinkers was computed for a 12-ounce sample and given brine strength by adding the total number of peas sinking from each quarter of the pan and multiplying the sum by 1.25.

3. Alcohol Insoluble Solids

A sample was defrosted as in the brine flotation test and placed in a flat bottom pan (approximately 8 to 9 inches bottom diameter). About 600 ml. of water at room temperature was added and the pan gently agitated in a circular motion for 30 seconds. The water was then decanted. This was repeated and the sample was then drained for 2 minutes on an 8-inch, No. 8 mesh woven wire cloth sieve. A representative subsample of about 100 g. was carefully removed and the exact weight was determined. This subsample was then placed in a blender cup with an equal weight of distilled water and blended for exactly 2 minutes. Exactly 20 g. (to the nearest 0.01 g.) of this blended mixture was placed in a 600 ml. beaker. To it was added 300 ml. of 80% alcohol (by volume). This mixture was stirred, covered, brought to a boil, and simmered for 30 minutes.

A Buchner funnel was fitted with a previously prepared filter paper of such size that its edges extended ½ inch or more up the vertical sides of the funnel. The previous preparation of the filter paper consisted of drying it in a flat-bottomed dish for 2 hours at 100° C., covering the dish with a tight-fitting cover, cooling it in a disiccator and promptly weighing.

The contents of the beaker were filtered with suction, care being taken not to allow any of the material to run over the edge of the paper. The beaker was rinsed with successive portions of 80% alcohol until no residue remained and the rinsings were poured over the residue on the filter paper. The residue on the filter paper was washed with 80% alcohol until the washings were clear and colorless. The filter paper, with the residue retained thereon, was transferred to the flat-bottomed dish used in preparing the filter paper and dried in a ventilated oven, with the cover off, for 2 hours at 100° C. At the end of this drying time the cover was placed on the dish, removed to a desiccator to cool, then weighed, and the percent of alcohol insoluble solids calculated.

4. Total Solids

A blended sample was prepared as was done for the alcohol insoluble solids determination. 5-7 g. (to the nearest 0.001 g.) of the blended mixture was weighed into a flat bottom dish, 9 cm. in diameter, which had previously been dried and tared. The procedure was followed as prescribed in *Official Methods of Analysis (4)*, page 531.

5. Color Index

A Hunter Color and Color-Difference Meter *(1)* was used. The sample was placed in a blender cup with an equal weight of distilled water and blended for exactly 2 minutes. The "Rd," "a," and "b" values of the sample were measured and the corrected "Rd," "a," and "b" values computed. The corrected "a" and "b" values were plotted on the DATA AND GRAPH SHEET FOR H.C.D.M. The resultant Color index or Color value was recorded.

IV. **Professional taste panels.** Samples companion to those subjected to objective test procedure were used for organoleptic evaluation by experienced taste panels. All scoring was completed without communication, consultation, or comparison among panel members on the specific factor being rated for each type of experimental samples.

The enzymatic-activity samples of frozen asparagus and peas were taste-tested by area panels in California, Maryland, and Oregon after 1, 3, 6, and 12 months' storage. Each area panel consisted of 6 industry food technologists from the quality control and/or production departments of freezers in that area and equally qualified personnel from buyers' groups. Top executive personnel unfamiliar with daily quality control problems were excluded from these panels. An individual was selected to head each area panel. This individual took charge of coding the samples, and therefore did not score them.

Each sample was prepared by cooking 10 minutes after the second boil in 1% salt solution. The samples were allowed to cool to room temperature, coded, and served to the taste panel in replicates of six for both products and each blanching variation. The flavor of each sample was scored as +2 for acceptable; +1 for slightly off-flavor, but acceptable; 0 for borderline flavor; −1 for off-flavor; and −2 for offensive flavor.

The fibrous asparagus samples and maturity pea samples were taste-tested by representatives of the Food and Drug Administration who joined the Research and Standards Committee in a panel conducted at the University of Maryland. Cooking and serving procedures were identical to those for enzymatic activity samples, except that the 24 variations on fibrous asparagus were replicated 4 times, the 86 variations on maturity peas were replicated twice, and the peas were cooked 6 minutes.

The texture of asparagus samples was scored +3 for tenderness characteristic of Fancy, Grade A; +2 for decreased tenderness with some fiber, characteristic of Extra Standard, Grade B; +1 for pronounced decrease in tenderness with additional fibrousness characteristic of Standard, Grade C; 0 for marginal fibrousness; −1 for undesirable fibrousness; and −2 for offensive fibrousness.

The maturity of peas was scored +3 for very tender peas reflecting Fancy, Grade A product; +2 for slight starchiness reflecting Extra Standard, Grade B maturity; +1 for additional starchiness reflecting Standard, Grade C maturity; 0 for marginal maturity; −1 for undesirable maturity; and −2 for offensive maturity.

SUMMARY

Objective methods of evaluating the quality of frozen asparagus and peas were studied independently by representatives of the Food and Drug Administration and the Research and Standards Committee of the National Association of Frozen Food Packers with consultations between the two groups from time to time. The methods include: (a) procedures for measuring residual acetaldehyde, catalase, and peroxidase in unblanched, half-blanched, normally blanched, and double-blanched frozen asparagus and peas after 0, 1, 3, 6, and 12 months' storage at 0° F. (−17.8° C.); (b) procedures for determining the sectional distribution of fiber in samples of frozen asparagus spears prepared from normal raw material in three areas of production by sizing and classification into eight series of resistive cutting pressures that were measured five inches from the tip end of the raw asparagus spears; (c) procedures for evaluating percent yellow peas, percent sinkers, percent alcohol insoluble solids, and color index for six

varieties of peas harvested in eight regions of production at tenderometer values ranging from 108 to beyond 200; and (d) organoleptic evaluation of off-flavor and maturity by experienced taste panels.

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Mandatory Standards Program on Quality Factors for Frozen Asparagus and Peas—An Industry Approach. III. Evaluation of Results[a]

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The logical development of grades and standards of quality requires first a definition of the quality characteristics to be measured, and a selection of possible methods for their measurement. These steps have been described in the preceding papers. The ensuing steps are described in this paper; namely, the evaluation of these selected methods by reference to sensory panels, the selection of the most suitable methods, if any, and finally the establishment of a borderline value which may serve as the limit of the acceptable quality range.

The precision, i.e. the reproducibility of any proposed objective test, may be determined rather easily by calculating the standard error between replicate values obtained on the same samples. The accuracy of the proposed test, however, may be established only by determining the degree of agreement of the test results with scores provided by panels of human judges. Thus a satisfactory sensory panel is all important in a study of this nature. The panel employed during this investigation is especially valid, since it consisted of groups of technologists accustomed to the routine grading of these products, drawn from different regions of the country.

Correlation analysis. After a comprehensive set of samples have been collected, and the objective test results and panel scores provided, the accuracy of each test may be determined by the use of a statistical technique known as correlation analysis. A correlation coefficient (r) of 1.0 or —1.0 indicates a perfect relationship between two sets of values, while a correlation of 0.0 indicates no relationship at all. Because of inherent errors in the test procedures themselves, and especially in the panel scores, a perfect correlation of 1.0 or —1.0 is practically impossible of attainment. However, provided there is a satisfactory range of samples, and a reasonably precise sensory panel, certain arbitrary standards of accuracy may be established in terms of correlation coefficients, as follows:

a. A correlation coefficient of 0.90 or higher between panel scores and the proposed test values, indicates that the test is satisfactory in reflecting human evaluation, since at least 81% of the variability among the samples may be explained in terms of the proposed objective test.

b. A correlation coefficient of 0.8 indicates that the test has promise and may be investigated further if no better test is available, with the hope that its accuracy may be improved upon. In this bracket, about two-thirds to four-fifths of the variability in quality of the samples may be explained in terms of the proposed objective test.

c. A correlation coefficient of less than 0.8, even if it is statistically significant, indicates that the test is not sufficiently accurate for use in determining the acceptability of the product, since more than one-third of the variability in quality among the samples cannot be explained in terms of the proposed test. In such cases where more accurate objective tests are not available only sensory methods are applicable.

Borderline values. Once a method is found which is correlated to panel scores to a sufficiently high degree, the borderline value between acceptable and unacceptable products in terms of that method may be determined by the calculation of a statistical term known as the regression equation, where the objective test value equivalent to borderline acceptability may be determined. Such a regression equation may be calculated for any relationship between two sets of values; however, if the correlation coefficient is not of a satisfactory magnitude, it is of little value.

Sampling problems. Obviously, individual packages of any given lot of a product will not give identical test results. This variability among units of the lot may be termed as the variability among packages. Furthermore, replicate determinations on the same packages will vary, depending on the precision of the method itself. This variability may be termed as variability within packages.

Thus, if a lot which is being tested happens to be

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[b] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, June 29, 1954.

exactly at the borderline level between acceptability and unacceptability, and a single determination is made of one package only, there is an even chance that the entire lot may be rejected on the basis of that single examination. Furthermore, if the lot actually averages somewhat better than borderline quality, there is still an almost even chance that the lot will be rejected. In terms of statistical sampling, this is known as the vendor's risk. Most sampling plans used by the military forces and by industry utilize sampling plans where the vendor's risk is usually not more than 5%, i.e., the vendor is required to take not more than one chance in 20 that an acceptable lot will be rejected on the basis of tests made on a sample of the lot *(3, 4)*.

If a similar approach would be taken with these mandatory standards, it would be necessary to resort to the use of a sampling plan involving the testing of considerably more than one package, or if that is not in keeping with the philosophy or regulations of the regulatory agencies, a safety factor should be introduced which would reduce the risk of rejecting acceptable lots to no more than one in 20. This may be accomplished by adding the value of two times the standard deviation among packages to the borderline value.

Tests for off-flavor. The coefficients of correlation and determination between panel scores and three objective tests proposed for determining off-flavor in peas and asparagus are presented in Table 1. The catalase test on asparagus is the only test whose correlation even

TABLE 1

Coefficients of correlation and determination between panel scores and objective tests proposed for determining off-flavor in frozen peas and asparagus

Test	Coefficients			
	Peas		Asparagus	
	Correlation (r)	Determination (r^2)	Correlation (r)	Determination (r^2)
Acetaldehyde (ppm)	—0.579	0.335	—0.696	0.484
Catalase (kr)	—0.790	0.624	—0.811	0.658
Peroxidase (Pv)	—0.708	0.501	—0.643	0.414

approaches borderline accuracy. This correlation is sufficiently high to invite research for a possible further improvement in accuracy. The correlations for acetaldehyde are particularly unsatisfactory, since they indicate that less than half of the variability in off-flavor among the samples is explained by variations in acetaldehyde content, whereas more than half is apparently due to other factors not associated with this measurement. This is true in spite of the fact that all the correlations shown in Table 1 are statistically significant.

By the regression of catalase values on panel scores, it was calculated that the catalase value equivalent to the borderline panel score is 0.214 K_t. It was further calculated that the standard deviation among packages of the same lot was 0.105 K_t. Since two times the standard deviation is equal to 0.214 K_t, about 95% of the individual packages will fall within a range of 0.214 $\pm$ 0.210. Thus, to insure the acceptance of a lot of asparagus which actually averages 0.214 K_t, 95% of the time, the minimum acceptable level should be set at 0.214 $\pm$ 0.210, or at 0.424 K_t.

If it were possible to set up a sampling plan consisting of more than one package, the minimum acceptable level could be raised towards the 0.214 value, since the error resulting from variability among packages may be reduced by the square root of the number of packages sampled. Thus, for example, a determination based on the analyses of 4 packages taken at random from the lot would justify the reduction of the minimum acceptable level to 0.319 K_t.[c] Increasing the number of packages sampled to 16 would justify the reduction of the minimum acceptable level to 0.266 K_t.[d]

Since the correlation coefficient between panel scores and catalase values for asparagus was —0.811, the test explains only about two-thirds of the off-flavor differences existing among the samples studied. As a consequence, greater accuracy is required before catalase could be established as a satisfactory test for hay-like off-flavors.

Maturity of peas. The coefficients of correlation between panel scores and objective tests for measuring the maturity of frozen peas are shown in Table 2. These

TABLE 2

Coefficients of correlation and determination between panel scores and objective tests proposed for determining maturity of frozen peas.

Test	Correlation coefficient (r)	Determination coefficient (r^2)
Alcohol Insoluble Solids	—0.920	0.846
Total Solids	—0.896	0.803
Tenderometer	—0.894	0.799
Sinker test, 15% + 16%	—0.760	0.578
Color (Hunter a/b)	—0.743	0.552
Sinker test, 15% only	—0.722	0.521
Sinker test, 16% only	—0.682	0.465

correlations may therefore be used to compare the accuracy of these proposed tests in determining the maturity of frozen peas. The Alcohol Insoluble Solids (AIS) method appears to be superior to the others listed; moreover, the high correlation of 0.920 indicates that this method is entirely satisfactory for the purpose, the coefficient of determination of 0.846 indicating that about 85% of the variability among the samples may be explained by differences in their A.I.S. content.

The remaining 15% variability may be due partly to imperfect precision in the methods. Another source of variability may be the possibility that this objective test may not measure the maturity of all varieties in the same manner as did the panel. That this is the case is shown in Table 3, where correlation coefficients are shown for individual varieties and regions. Since all these correlations are significantly higher than the one combining all the data, it may be concluded that further accuracy may be achieved by establishing separate limits for each variety and or region. Thus the A.I.S. percent which is equivalent to the borderline panel score for the Dark Skinned Perfection variety grown in Washington is only 20.6%, as compared to 24.3% for the Wyola variety grown in California.

Whether the added accuracy is of practical significance is open to question. Assuming that separate limits for each variety are not feasible, the statistical calcula-

[c] 0.424 K_t — (0.214 + 0.210/$\sqrt{4}$) = 0.319 K_t.

[d] 0.424 K_t — (0.214 + 0.210/$\sqrt{16}$) = 0.266 K_t.

TABLE 3

Coefficients of correlation between alcohol insoluble solids and panel scores, and A. I. S. values equivalent to borderline scores, calculated for each variety and/or region separately.

Variety and location	Correlation coefficient (r)	% A.I.S. equiv. to panel borderline
All samples	—0.920	22.4
Laxton variety	—0.964	22.2
Glacier, N. J.	—0.984	22.6
Laxton, N. J.	—0.972	22.5
Victory Freezer, N. J.	—0.977	21.0
Shasta, N. J.	—0.971	23.9
Laxton, Maine	—0.970	22.0
Laxton, N. Y.	—0.992	21.1
Laxton, Minn.	—0.986	22.8
Laxton, Ore.	—0.971	23.4
Wyola, Cal.	—0.983	24.3
Laxton, Md.	—0.994	21.4
Dark Skinned Perfection, Wash.	—0.982	20.6

tions and the indicated minimum acceptable level for frozen peas treated as a whole would be as follows:

Equivalent to panel borderline score	22.4% A.I.S.
Variability among packages	1.2
Minimum acceptable level	23.6% A.I.S.

Again as in the case of the catalase test, any increase in the number of packages tested would justify moving the minimum acceptable level towards 22.4% A.I.S.

Since the minimum acceptable level of maturity for canned sweet peas is 21.0% A.I.S. *(6)*, it may be reasoned that the level for frozen peas should be the same or even lower. Such a conclusion, however, does not take into consideration the fact that peas particularly at the standard-substandard level soak up considerable quantities of water from the liquor during the canning process. Since frozen peas are not packed in a liquid medium there can be no similar soaking up of water for frozen peas, so that the insoluble solids percent of frozen peas is invariably higher than that of canned peas prepared from the same raw material. In fact, when four lots of raw peas whose average A.I.S. content was 22.5% were canned and frozen, the A.I.S. content of the canned peas was 18.4%, as compared to 22.0% for the frozen product.

Fibrousness of asparagus. The coefficients of correlation between panel scores and objective tests proposed for measuring fibrousness of asparagus are presented in Table 4. Since the relationship between these tests and panel scores was not linear, a curvilinear relationship was indicated, and the curve of best fit was found to be logarithmic in nature. This is in agreement with data reported previously *(2)*, and actually means that successively larger increments of fiber are required to effect successive increments in panel scores for fibrousness of equal magnitude.

TABLE 4

Coefficients of correlation between panel scores and objective tests proposed for determining fibrosity of frozen asparagus

	Correlations		
	Linear (r)	Logarithmic (r)	Rank (P)
Fiber, %:			
bottom ½" only	—0.802	—0.912	0.879
bottom 1 inch	—0.765	—0.894	0.825
bottom 2 inches	—0.742	—0.861	0.787
entire spear	—0.713	—0.775	0.792
Fibrometer, % no-cut	—0.890	—0.908	0.877

Because of this curvilinear relationship, the correlation coefficients were improved materially when panel scores were correlated with the logs of the fiber values as compared to the actual fiber values. It is also evident from the data in Table 4, that the fiber content of the bottom half inch of the stalks gives the best indication of panel scores. The correlation between percent no-cut, as obtained with the use of the fibrometer, and panel scores was also satisfactory. Thus the minimum acceptable level of fibrousness for frozen asparagus may be established as follows:

	Percent fiber in bottom half-inch of the stalks	Fibrometer, percent no-cut
Equivalent to borderline panel score	0.360	42.0
Variability among packages	0.120	16.0
Minimum acceptable level	0.480	58.0

Here also, as the number of packages to be sampled is increased, the minimum acceptable level may approach 0.36% for percent fiber, and 0.42% no-cut for the fibrometer test.

SUMMARY

The possibility of utilizing one of three chemical procedures as a mandatory standard for off-flavor in asparagus and peas was investigated with the conclusion that the acetaldehyde and peroxidase tests are not suitable, whereas the catalase test may become satisfactory provided its accuracy in predicting off-flavor can be improved.

The A.I.S. test was found to be satisfactory as the basis for a mandatory standard for maturity of frozen peas, with the minimum acceptable level calculated at 23.6%. This level could be reduced towards 22.4% as the number of packages to be tested is increased.

Both percent fiber in the bottom half inch of the stalk, and percent no-cut with the fibrometer were found suitable for use in mandatory standards of fibrousness in frozen asparagus, with the minimum acceptable levels calculated at 0.48 and 58.0, respectively. These levels could also be reduced towards 0.36 and 42.0, respectively, as the number of packages to be tested is increased.

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Further Studies of Butyric Fermentation in Canned Tomatoes[a]

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(Manuscript received April 23, 1954)

Butyric fermentation of canned tomatoes by Clostridium pasteurianum is associated with high pH values in the canned product. Spoilage may be controlled by processing to can centre temperatures of 200° F. (93.3° C.) and by the addition of citric acid to reduce the pH. No undesirable effect on flavour or colour was observed in samples containing up to 0.2% added citric acid where the increased acidity was balanced with added sucrose.

In a previous paper *(2)* the authors described a case of so called "butyric" fermentation, caused by *Clostridium pasteurianum*, in commercially canned tomatoes. Investigations *(2, 5)* have shown that this type of spoilage is asociated with a high pH in the product. Townsend *(5)* has suggested acidification of canned tomatoes, pears, and figs as a means of controlling spoilage by *Cl. pasteurianum*. In work with Flemish Beauty pears *(2)* it was found that citric acid added to the canned product prevented fermentation by this organism. However, it appeared at the time that acidification of canned tomatoes would have an undesirable effect on flavour, and that the inhibiting effect of the acid would vary greatly, due to the solid nature of the product preventing rapid equalization in the container.

Canned tomato products from British Columbia factories show pH values ranging from a minimum of 4.0 to a maximum of approximately 4.6 with a mean of 4.32. This indicates that a large proportion of the product is in the pH range where butyric fermentation might be encountered.

The present study was undertaken to find the conditions under which spoilage of tomato products by *Clostridium pasteurianum* will occur and to devise means by which it may be controlled.

EXPERIMENTAL PROCEDURE

Whole and pureed tomatoes were canned, inoculated and processed under various conditions of pH and temperature. The test organism used was the strain of *Costridium pasteurianum* isolated from fermented canned Flemish Beauty pears, and also found to cause spoilage in canned tomatoes *(2)*. The cans were inoculated by introducing one ml. of spore suspension, containing approximately 200,000 spores, into the centre of each can. Control cans, containing no inoculum were prepared at the same time. Twenty fluid ounce (307 x 409) cans were used.

In the first series of tests, tomatoes were peeled, pureed, and the pH adjusted with 20% citric acid or 20% sodium hydroxide before canning, to give values in the finished product varying from 4.0 to 4.7. In the second series, whole tomatoes were peeled, placed in cans, and citric acid added to give 0.05%, 0.1% and 0.2% concentrations in the final product. Sucrose, in concentrations of 0.5%, 1% and 2%, respectively, was added to balance the acidity. The amounts of sucrose required were determined in previous taste trials.

The prepared cans were exhausted for 4 minutes in steam at 208°-210° F. (97.8-98.9° C.), sealed, and processed in boiling water. Temperatures were recorded during exhausting and processing by means of the Brown Electronik Potentiometer. Four cans of each batch processed were used to record temperature, the copper-constantan thermocouples being inserted in the geometric centres of the cans.

In both series the cans were processed to a mean centre temperature of 190° F. (87.8° C.) with minimum and maximum figures of 183° F. (83.9° C.) and 193° F. (89.4° C.) being recorded. The average batch process time was 35 minutes, with a minimum of 30 minutes and a maximum of 43 minutes.

To observe the effect of increased temperature, duplicates of each series of cans were processed in boiling water until all cans reached a minimum centre temperature of 200° F. (93.3° C.). Centre temperatures, except for one extreme value of 209° F. (98.3° C.), fell between 200° F. (93.3° C.) and 204° F. (95.6° C.). The average process time for individual runs was 61 minutes, with a minimum of 50 minutes and a maximum of 68 minutes.

Immediately after processing, all cans were water cooled to a temperature of 70° F. (21.1° C.) and stored at 80°-85° F. (26.7°-29.4° C.). Examination for swollen cans was made daily over a period of 12 weeks.

EXPERIMENTAL RESULTS

Table 1 shows the effect of variation in pH and processing temperature on the growth of *Clostridium pasteurianum* in pureed tomatoes. No spoilage occurred in samples in the pH range 4.0-4.1, regardless of the can centre temperature reached at completion of the process.

At pH 4.3-4.4, 100% of the samples processed to can centre temperatures of 183°-193° F. (83.9°-89.4° C.) showed spoilage. None of the samples in the same pH range, processed to 200°-204° F. (93.3°-95.6° C.), spoiled.

TABLE 1

Effect of pH and process temperature on growth of Clostridium pasteurianum in canned pureed tomatoes

pH	Can centre temperature at end of process ° F.	No. of samples	No. of samples fermented	% samples fermented
4.0–4.1	183–193	24	0	0
	200–204	24	0	0
4.3–4.4	183–193	24	24	100
	200–204	24	0	0
4.7	183-193	11	11	100
	200–204	12	7	58

At pH 4.7, 100% of the samples processed to temperatures of 183°-193° F. (83.9°-89.4° C.), and 58% of the samples processed to temperatures of 200°-204° F. (93.3°-95.6° C.) showed spoilage.

Table 2 shows the effect of adding various concentrations of citric acid to whole tomatoes and processing to different can centre temperatures. Eighty-three percent of the untreated samples (pH 4.3-4.4) processed to temperatures of 183°-193° F. (83.9°-89.4° C.) fermented. Corresponding samples processed

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to centre temperatures of 200°-204° F. (93.3°-95.6° C.) did not ferment.

Samples containing 0.05% citric acid showed pH values of 4.1-4.35. Of the cans so treated, those processed to temperatures of 183°-193° F. (83.9°-89.4° C.) showed 75% spoilage, while only 25% of those processed to 200°-204° F. (93.3°-95.6° C.) fermented.

The addition of 0.1% citric acid reduced spoilage in cans processed to 183°-193° F. (83.9°-89.4° C.) can centre temperatures to 25% of the samples, while those processed to 200°-204° F. (93.3°-95.6° C.) showed no spoilage. Acidification to 0.1% resulted in pH values of 4.1-4.32.

Samples containing 0.2% citric acid showed no spoilage in either temperature range. The pH resulting from this treatment was 4.0-4.2.

All inoculated samples were subjected to taste panel tests. With added acid not exceeding 0.2%, balanced by the addition of sucrose at approximately 10 times the concentration of acid used, no undesirable effect on flavour or colour resulted.

DISCUSSION

The data show that the fermentation of canned tomatoes by *Clostridium pasteurianum*, as in the case of Flemish Beauty pears, is related to the pH of the product. It would appear that current standard processes, giving can centre temperatures of 183°-193° F. (83.9°-89.4° C.) are entirely satisfactory for tomatoes with pH values below 4.2. However, if the pH should be in the range 4.3-4.4, as is the case with a large proportion of the tomatoes produced in British Columbia, then processing to yield can centre temperatures of 200°-204° F. (93.3°-95.6° C.) would be necessary to control spoilage by this organism. Even with these process temperatures occasional spoilage might be encountered at pH 4.4.

In the case of tomatoes of pH values exceeding 4.4, processing to can centre temperatures of 200° F. (93.3° C.) likely would be insufficient to prevent excessive spoilage. For tomatoes in this pH range, acidification of the product appears to be one solution.* If a process yielding can centre temperatures of 200°-204° F. (93.3°-95.6° C.) is to be used, the pH of the product should be lowered to 4.3. For processes yielding temperatures of 183°-193° F. (83.9°-89.4° C.) the pH should be reduced to 4.2. Lowering the pH of the product to this range, 4.2-4.3, usually may be accomplished by the addition of 0.1-0.2% citric acid. If the tomatoes show exceedingly high pH values, e.g. pH 4.6 or higher, then 0.3% acid concentration might be required to reduce the pH to about 4.3. By balancing the added acid with sucrose, flavour and colour are not adversely affected. *However, in order to maintain flavour it is desirable to add the minimum amount of* acid.

Another possible solution is to pressure cook tomatoes having pH values exceeding 4.4. From studies recently conducted, pressure cooking of canned tomatoes in 20 oz., 28 oz., and 105 oz. size cans at temperatures up to 250° F. (121.1° C.) to can centre temperature of 190° F. (87.8° C.) produced no deleterious effects in colour, wholeness or flavour *(1)*. Can centre temperatures exceeding 200° F. (93.3° C.), sufficient to destroy *Clostridium pasteurianum*, might be obtained by pressure cooking without lowering the quality of the product. Where pressure cookers are available, high temperature processes have distinct advantages. The feasibility of pressure cooking to control butyric spoilage in tomatoes of high pH values is being investigated.

Discrepancies in the data on acidification may be noted in Table 2. A possible explanation is that canned tomatoes are not a homogeneous product. The added acid can not be distributed evenly in the container, with the result that the more solid material could conceivably remain at a high pH for some time. This might permit fermentation to take place before the acidity of the product is equalized throughout. For the same reasons heat penetration may be uneven.

TABLE 2
Effect of added citric acid on canned whole tomatoes processed at different temperatures

% Citric acid added	% Sucrose added	pH range of finished product	Can centre temperature at end of process ° F.	No. of samples	No. of samples fermented	% samples fermented
0.00	0.0	4.3–4.40	183–193	12	10	83
			200–204	12	0	0
0.05	0.5	4.1–4.35	183–193	12	9	75
			200–204	12	3	25
0.10	1.0	4.1–4.32	183–193	12	3	25
			200–204	12	0	0
0.20	2.0	4.0–4.20	183–193	12	0	0
			200–204	12	0	0

In Table 2 it may be seen that the addition of acid in concentrations of 0.05% and 0.1% resulted in lowering of the pH to the almost identical values of 4.1 to 4.32 or 4.35 respectively, yet more effective control of spoilage was obtained at the 0.1% acid level. This suggests that the undissociated acid may have an inhibiting effect on fermentation. Levine and Fellers *(3, 4)* have shown that the toxic effect of acid on microorganisms is not due to pH alone.

SUMMARY

The problem of butyric fermentation of canned tomatoes has been studied.

No spoilage has been observed in pureed tomatoes adjusted with citric acid to pH 4.0-4.1, even with can centre temperatures at the end of processing as low as 183° F. (83.9° C.).

In the pH range 4.3-4.4 all pureed samples processed to temperatures of 183°-193° F. (83.9°-89.4° C.) showed spoilage, while none processed to 200°-204° F. (93.3°-95.6° C.) spoiled.

At pH 4.7 all pureed samples processed to 183°-193° F. (83.9-89.4° C.) fermented, as did 58% of those processed to 200°-204° F. (93.3°-95.6° C.).

Untreated whole canned tomatoes at pH 4.3-4.4, processed to 183°-193° F. (83.9°-89.4° C.) showed 83% spoilage while corresponding samples processed to centre temperatures of 200°-204° F. (93.3°-95.6° C.) did not ferment.

* At present citric acid may not be added to canned tomatoes in Canada. However, the addition of citric acid to canned Flemish Beauty pears in concentrations not exceeding 0.3% in the syrup recently has been allowed in order to reduce the incidence of spoilage by *Clostridium pasteurianum*.

The addition of 0.2% citric acid to whole canned tomatoes, giving pH values of 4.0-4.2, prevented fermentation in all samples. Addition of 0.1% acid, giving pH values of 4.1-4.32, was not as effective as 0.2% acid in preventing fermentation since 25% of samples processed to 183°-193° F. (83.9°-89.4° C.) spoiled. None of those processed to 200°-204° F. (93.3°-95.6° C.) spoiled with the 0.1% acid treatment.

No undesirable effect on flavour or colour was observed in samples containing up to 0.2% added citric acid where the increased acidity was balanced with added sucrose.

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Theoretical Considerations in Food Processing by Gamma Radiations

I. Cylindrical Absorbers Within a Cylindrical Source

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A method for calculating the minimum time required for processing food in containers exposed to gamma radiation is presented. Criteria for thermal process calculations previously described are applied since, regardless of the type of processing, the same degree of microbiological destruction must be maintained. The present study is concerned with calculations for absorbers inside the source only; calculations for absorbers outside the source will be presented in a sequel study.

The potential widespread use of nuclear fission for generation of power in the not too far distant future should make available considerable amounts of waste isotopes which may be utilized for processing foods and drugs. It has been demonstrated that organoleptic properties of foods are affected by radiation exposure in doses required for sterilization. For this reason it is extremely important to avoid unnecessary overexposure or overdose in any part of a material being treated (the absorber) and likewise to achieve as uniform a distribution of dose (ionization) within the absorber as possible.

The problems involved in evaluating radiation exposure are similar to those involved in thermal process evaluation. In a sense, heat is a form of radiation, but of different wavelength from the gamma radiation with which we are concerned in this instance. Regardless of the type of processing, the same degree of microbiological destruction must be maintained.

The concepts of thermal process evaluation developed by Stumbo *(3)* can be applied to radiation processes. Stumbo's method considered the lethal effects at various regions in the container and summed up the number of bacteria surviving in these various regions in order to determine the number of organisms remaining viable in the container. The safe thermal process is defined as one sufficient to reduce the most dangerous resistant organisms surviving in the container to approximately 2×10^{-10} *(3)*. This is usually *Cl. botulinum* for vegetable products and Clostridium spp. PA 3679 for meat products. The initial concentrations for these products have been found to average about 10 spores/g.

It has been found that heat-resistant organisms in general are also radiation resistant *(2)*. The exact degree comparative of resistance to the two types of energy has yet to be determined for many species of organisms. However, further studies along these lines are under investigation. It is assumed at the present time by the authors that radiation processes should be evaluated with respect to the same organisms as thermal processes.

Some investigations have been made by the Vitro Corporation *(4, 5)* on methods for evaluating radiation intensity or dose rate and exposure time from which have been evolved equations relating dose rate to size and geometry of the source *(4, 5)* for absorbers both inside and outside the source.

The present paper is concerned with calculations for absorbers inside the source only. A subsequent paper will present the development of calculations for absorbers outside the source. The Vitro equation for the average dose rate along the axis of a hollow cylinder (Figure 1) filled with an absorber of radius "R_i" equal to the inner

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Contribution No. 197 from the Department of Food Technology, Massachusetts Institute of Technology, Cambridge, Massachusetts.

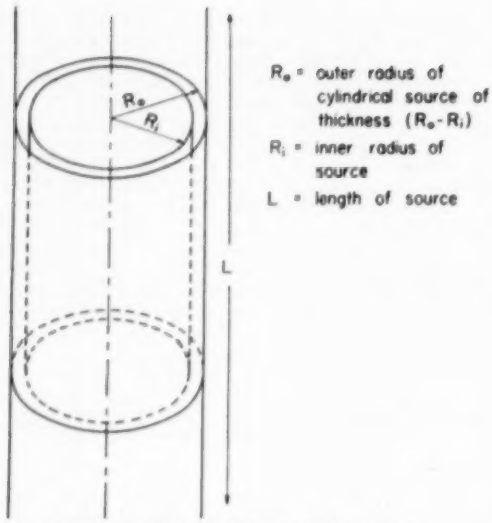

Figure 1. Sketch of hollow cylinder source.

radius of the source of specific activity "ρ" (curies per unit area) is:

$$\bar{D} = 4\pi K_1 \rho \beta \qquad (1)$$

where:

$\bar{D}$ = dose rate (rep/sec)
K_1 = conversion constant
ρ = curies per unit area (C_A)
β = function L/R_1; μR_1
μ = linear absorption coefficient of absorber (cm^{-1})
L = length of source

The procedure employed by the Vitro Corporation, using the above equation for calculating the exposure time required for sterilization, consists of determining the length of time for the points of least dose rate to absorb 2,000,000 rep *(4, 5)*. The assumption that a dose of 2,000,000 rep at the center will result in a sterilizing dose for the container may not be valid, however. The number of organisms surviving in the container is the sum of the probability of survival at every point in the container. It is conceivable that the sum of the probabilities of survival throughout the container must be greater than the probability of survival at the center even though the center received the least lethal dose. Thus, the important point that should be considered is not the probability of survival at the point (or line) of least dose rate but rather the probability of survival in the entire container. In order to attain the safety of thermally processed foods, the sterilizing dose should be sufficient to reduce the most resistant, dangerous organisms associated with the food from 10 spores/g. to about 2×10^{-10} organisms per container.

The Vitro method assumes a container geometry different from the actual one found *(5)*. For example, in the Vitro study it was proposed to irradiate 363 rectangular cans $3^{13}/_{16}$ inches x $2^{1}/_{16}$ inches, with a hollow cylinder 12 inches in diameter and 33 inches long. This arrangement provides for treatment of 99 cans inside the hollow cylinder and 264 cans outside each cylinder. The simplifying assumption is made that processing 363 cans with a unit hollow cylinder is equivalent to irradiating a solid core of meat 12 in. in diameter within the cylinder and irradiating a cylindrical core of meat outside the hollow cylinder at a radial distance of about 4.32 inches. The latter dimension was established so the dose rates inside and outside the cylinder would be equal.

This simplifying assumption distorts the real problem of determining the minimum exposure time for the safe processing of each can inside or outside the hollow cylinder. Due to the uneven dose rate distribution throughout the container, the cans inside the cylinder will receive various doses; some cans will be over-exposed and some under-exposed with regard to bacterial safety. This, of course, results in a pack having heterogeneous quality and possibly questionable safety.

This paper describes a method for calculating the minimum time required to process containers safely when they are exposed to gamma radiation. This method takes into account the criteria for thermal process calculations previously described . It has been found by the Vitro Corporation that if the fission product source is arranged in the shape of a thin hollow cylinder, the most efficient use of the radiation is made. This is due to less self-absorption of radiation within the source material and a smaller amount of loss from the ends than is found in some other arrangements *(5)*.

For irradiating inside a hollow cylinder a container which is of the same radius as the cylinder results in the most efficient absorber. Containers of smaller radii would permit more loss of radiation from the ends of the cylinder.

For this study, the most efficient conditions will be assumed, *i.e.*, absorbers which have the same radius as the source as they travel through a hollow cylinder.

In order to determine the number of bacteria surviving a specified exposure of the container, the dose rate at various points along the radius of the container must first be determined.

The intensity of radiation at any point "P" in the container (Figure 2) due to a differential ring of the hollow cylinder source is:

$$I_P = \frac{k}{4\pi} \int_0^{2\pi b} \frac{e^{-\mu_P r}}{r^2}\, ds \qquad (2)$$

where:

$\frac{k}{4\pi}$ = strength (curies) in any direction due to a point source (B)
I_P = intensity at P
b = radius of container and also inside radius of hollow cylinder
μ_P = absorption coefficient of absorber
ds = differential length of ring
r = distance to point P

Since $ds = b d\theta$, where θ is the central angle in the ring, Equation 2 may be rewritten:

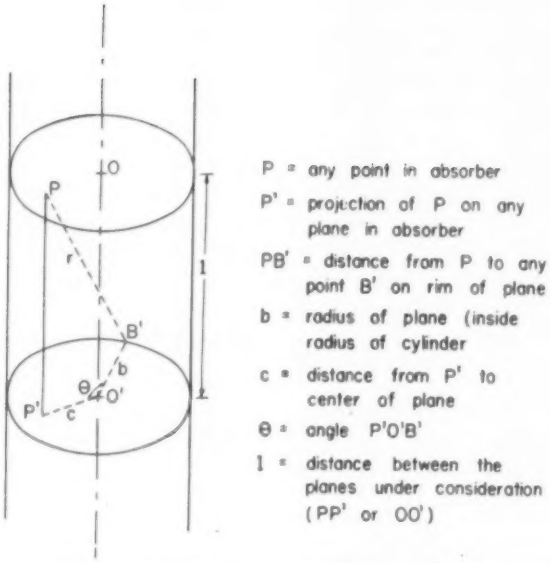
O
P
r
B'
b
θ
O'
P'
c
T
l
P = any point in absorber
P' = projection of P on any plane in absorber
PB' = distance from P to any point B' on rim of plane
b = radius of plane (inside radius of cylinder
c = distance from P' to center of plane
θ = angle P'O'B'
l = distance between the planes under consideration (PP' or OO')

Figure 2. Sketch illustrating the radiation received by any point "P" in absorber from any point "B" of source.

$$I_P = \frac{2kb}{4\pi} \int_o^\pi \frac{e^{-\mu_\rho r}}{r^2}\, d\theta \qquad (3)$$

It now remains to calculate the dose rate received by point "P" from all points on all differential elements, ds. This is designated as "D_P":

$$D_P = \int_o^L I_P dl \qquad (4)$$

$$D_P = \frac{2KC_A b}{4\pi} \int_o^L \int_o^\pi \frac{e^{-\mu_\rho r}}{r^2}\, d\theta dl \qquad (5)$$

where C_A is the strength of the source per unit area (curies per cm^2).

K is the constant to convert the average energy (E) of a fission product source from curies to rep/sec.

Since (by law of cosines):

$$r = \sqrt{l^2 + c^2 + b^2 - 2cb\cos\theta}$$

Equation 5 may be rewritten:

$$D_P = \frac{2KC_A b}{4\pi} \int_o^L \int_o^\pi \frac{e^{-\mu_\rho \sqrt{l^2+c^2+b^2-2cb\cos\theta}}}{l^2+c^2+b^2-2cb\cos\theta}\, d\theta dl \qquad (6)$$

Equation 6 may be solved graphically.

Figure 3 presents the dose-rate ($\bar{D}_c$) distributions thus obtained along a line parallel to the "Y" axis to "c" units away from it.

The average dose rate, $\bar{D}$, along a line parallel to the "Y" axis and "c" units away ($\bar{D}_c$) may be obtained from Equation 7:

$$\bar{D}_c = \frac{1}{L} \int_o^L D_c\, dl \qquad (7)$$

By multiplication of the average dose rate ($\bar{D}_c$) and the exposure time, one obtains the value for the total dose along the particular axis.

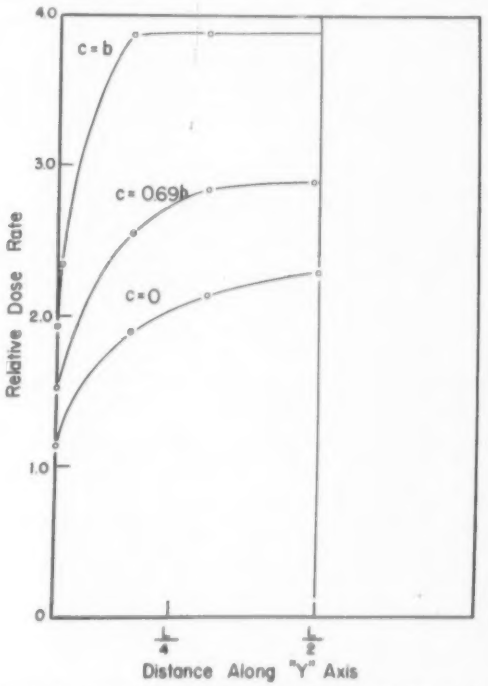

Figure 3. Dose distribution along lines parallel to axis of cylinder of radius "b," of height "L," and various distances "C" from the axis.

Figure 4 presents a plot of the average dose rate ($\bar{D}_c$) vs. distance from axis. It is to be observed that the average dose rate $\bar{D}_c$ varies appreciably according to the distance from the source.

When a determination has been made of the average dose rate at various points in the container as it travels

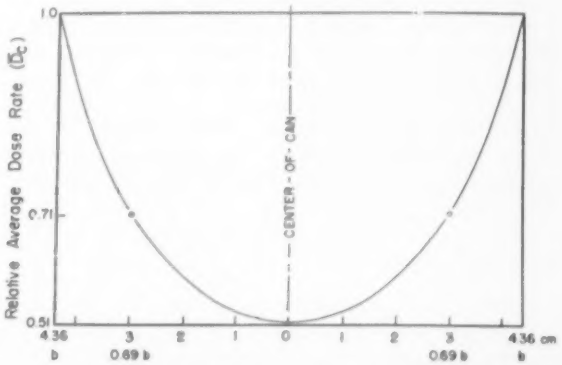

Figure 4. Dose rate distribution in hollow cylinder filled with absorber ($\mu = 0.074$ cm^{-1}).

the length of the hollow cylinder source, the number of survivors in the container may be estimated. This estimation, which is based on Stumbo's concepts for evaluating thermal processes, consists in totaling the most probable number of organisms in the container surviving the various lethal effects throughout the container *(3)*. A cylindrical can being irradiated has the regons of equal lethality arranged in the form of concentric cylinders the same height as the container (Figure 5).

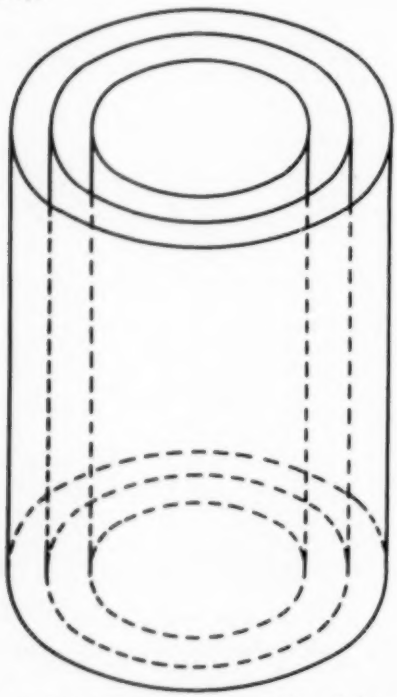

Figure 5. Sketch illustrating concentric cylinders of equal lethality.

The lethality at each concentric cylinder of radius "c" may be determined from the average dose rate ($\bar{D}_c$) associated with that concentric cylinder calculated by the previously described procedure.

The bacteria in the container can be considered as distributed evenly on the surfaces of the various concentric cylinders within the container. The number of bacteria on any concentric cylinder is proportional to the curved surface area of that cylinder. Therefore, since it is possible to determine the dose and initial number of organisms associated with a concentric cylinder, it is possible to calculate the number of organisms surviving on a concentric cylinder by use of the classical target theory equation:

$$n = n_o e^{-\bar{D}_c t/D_o} \qquad (8)$$

where:

n = number surviving/unit volume
$\bar{D}_c$ = average dose rate
t = exposure time
D_o = 37% inactivation dose of organism
n_o = initial number of organisms/unit volume

These concentric cylinders being of infinitesimal thickness can be thought of as differential volumes "dv" of the container. Thus, the most probable number of bacteria surviving a given exposure time in a volume may be calculated from the equation:

$$\int_o^v n\,dv = \int_o^v n_o e^{-\bar{D}_c t/D_o}\,dv \qquad (9)$$

since, $v = \pi c^2 h$ (volume enclosed by concentric cylinders)

differentiating, $dv = 2\pi h c\,dc$

$$\therefore \int_o^v n\,dv = \int_o^c 2\pi c h n_o e^{-\bar{D}_c t/D_o}\,dc \qquad (10)$$

Equation 10 can be conveniently integrated graphically by plotting $n_o e^{-\bar{D}_c t/D_o}$ against $\pi c^2 h$ or v and computing the area under the resulting curve. This has been done for examples using 28,000; 29,000 and 30,000 seconds as "t" and a constant average dose rate $\bar{D}_c$, and plotted in Figure 6.

By plotting the area under each curve (the most probable number of survivors per container) vs. the respective exposure time, one can find the exposure time required for a given lethality (Figure 7).

By plotting the number of survivors vs. distance from the center (Figure 8), one can obtain a plot of the distribution of organisms for a given time of exposure. As the time increases (and, also, therefore, the total dose), the point of most probable survival (within a cylindrical source) approaches the center of the container since the dose rate is least at the center (the line

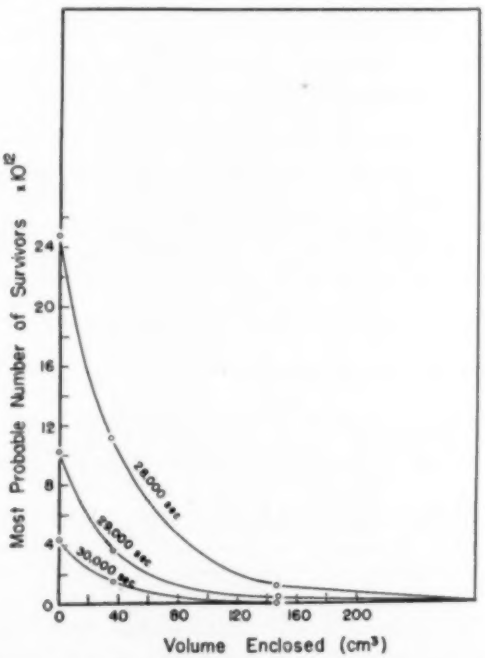

Figure 6. Plot of most probable number of survivors on surfaces of concentric cylinders exposed to three different irradiation periods.

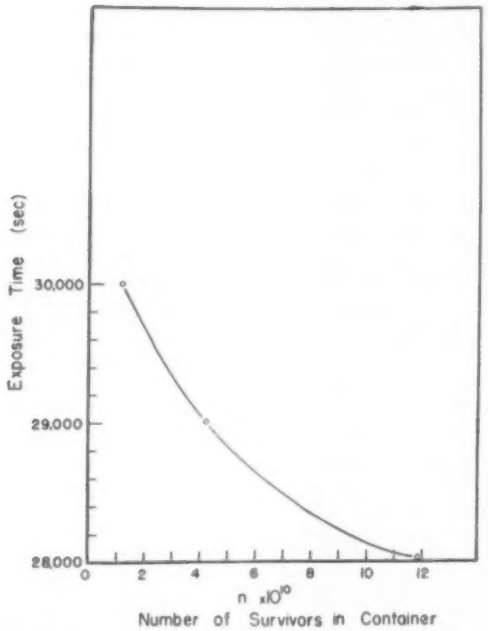

Figure 7. Time of exposure (dose) vs. number of survivors in container.

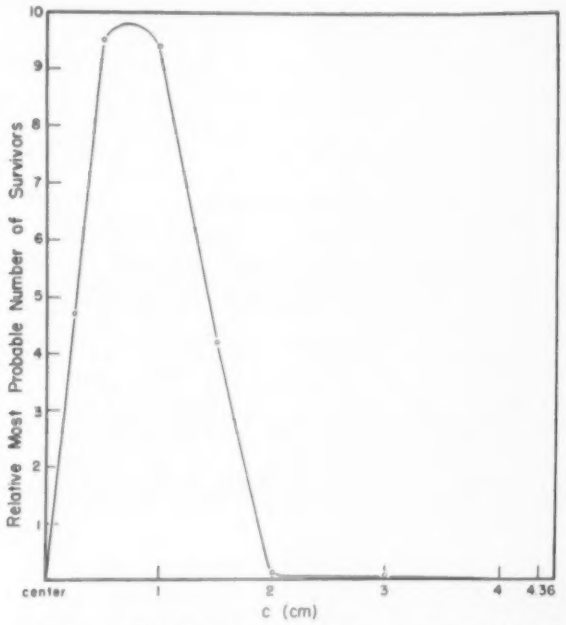

Figure 8. Plot of number of survivors on the surfaces of concentric cylinders vs. radius of container (exposure time of 30,000 seconds).

farthest from the source). It should be pointed out, however, that the volume of concentric cylinders (or the total number of organisms) is greatest away from the center.

Therefore, in a cylindrical absorber contained within a cylindrical source, even though the outermost layers of the absorber (which are closest to the source) receive a higher dose rate, the probability of survival is greatest in this region because of the larger number of organisms. Hence the simplification of the Vitro method may not be valid. However, regardless of its validity, the Vitro method unfortunately does not take into account modern concepts of container geometry and of contaminant. The point, line or surface of minimum dose is not the single factor on which to base a radiation sterilization process.

This paper is not intended to be a criticism of the Vitro method but rather is intended to supplement it. On the basis of the Vitro calculations, it is possible to integrate the newer knowledge of thermal processing and container geometry into a rational approach to radiation processing by use of isotopic sources.

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Maturity of Bartlett Pears for Canning

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The changes in chemical and physical properties of Bartlett pears accompanying storage at 34° F. and ripening at 70° F. have been investigated. These include texture, color, soluble solids, total acids, ascorbic acid, and tannin content. Fresh Bartlett pears of different degrees of ripeness were analyzed for the above properties and canned in 25° Brix sucrose syrup. Comparison of organoleptic acceptance data of these canned pears with the chemical and physical properties of the fresh pears has shown that a definite relationship exists between the pressure-test rating of the raw pears and flavor preference for the canned product. Chemical analysis of volatile reducing substances has been found to be a promising objective method for evaluating flavor and aroma of canned Bartlett pears.

Several studies have been published concerning maturity standards for harvesting Bartlett pears *(1, 10, 19)*. Color and firmness are the basis of the maturity standards adopted as a part of the California Fruit, Nut, and Vegetable Act of 1929. The firmness of Bartlett pears for fresh fruit shipment must range between 18 and 20 pounds pressure p.s.i. and not exceed 23 pounds as measured by a Ballauf fruit pressure tester. Pears in this range are very immature and unpalatable; therefore they must be stored and ripened. During this storage and ripening period there are two primary considerations: First, the pears must be transported to the point of processing and held until the production schedule permits processing; second, they must be ripened uniformly to the best possible dessert quality. Usually they can be kept for two months at 29° to 30° F. and 90% relative humidity, provided they are harvested at proper maturity and cooled quickly—within 24 hours—to 31° F. *(6)*. Studies on the keeping quality of Bartlett pears under cold storage have been published by several workers *(5, 6, 14, 19)*. Before marketing, the cold-storage pears must be ripened at 68° to 70° F. for 4 to 5 days to get the maximum dessert quality, which was observed in this study to correspond to 2 to 4 pounds pressure test.

Proper maturity of Bartlett pears at canning time is important to the quality of the canned product. Claypool and co-workers *(10)* made firmness tests of Bartlett pears during the canning season of 1950 in 13 canneries located at regions of different climatic conditions in California. They designated pears of 2 pounds pressure test and less as overripe and those over 5 pounds as too green for canning. Opinions among canners differ as to the best stages of ripeness of Bartlett pears for canning. The range of pressure test of Bartlett pears used by California canners is quite variable *(10)*. A further complication is the difference in quality of pears grown at different localities under differing soil conditions, cultural practices, and climatic conditions.

The nature of the physical and chemical changes accompanying maturation of Bartlett pears has not been thoroughly investigated. It has therefore been difficult to establish the relationship between the maturity of fresh pears before canning and the acceptance of the finished product. This investigation was undertaken to describe the physical and chemical changes of Bartlett pears stored at 34° F. and ripened at 70° F. With this information to supplement the pressure test, a series of samples of pears of different maturities was canned. The acceptance data of these canned pears were then correlated with the physical and chemical properties of the fresh fruits.

EXPERIMENTAL MATERIALS AND METHODS

Bartlett pears. The pears used in this investigation were harvested on July 22, 1952, from the Di Giorgio Ranch, Marysville, California. Before harvest the pears were sprayed with chemicals according to the following program:

Blossom period: Three dustings of 20-80 copper-lime dust at 25 pounds per acre.

April 11, petal-fall application: All plots received 15.5 pounds per acre of 50% wettable DDT, 45 pounds per acre of wettable sulfur, and 13.5 pounds of Basicop per acre.

April 25: All plots received 10.5 pounds 50% wettable DDT per acre and 13.5 pounds of Basicop per acre.

May 10: All plots received 10.5 pounds per acre of 50% wettable DDT.

June 10-July 22: All plots received 3 applications of water in an attempt to hold down mite population.[a]

Immediately after harvest 2 tons of pears were hauled to Davis and stored at 34° F. The pressure test of the fresh pears was about 18-20 pounds p.s.i. At designated time intervals 400-pound batches were removed to a 70° F. room for ripening. Pears were canned at different stages of maturity, as judged by pressure test and skin color. Representative samples of each batch were investigated for their chemical and physical properties.

Physical and chemical tests. Ten representative pears, ranging from 2½ to 2⅝ inches in diameter, were taken from each batch for the investigation of physical and chemical properties. The samples were randomly drawn.

Skin color. The pears were first cleaned with a towel. Their skin color was compared with the color chart in Maerz and Paul's *Dictionary of Color (18)* and Allen's color charts *(1)* for Bartlett pears. A standard light source[b] that approaches bright sunlight was used.

Texture. Pressure tests on the fresh pears were made with two Ballauf fruit pressure testers equipped with a plunger 5/16 in. in diameter. These pressure testers had a range from 0-30 or 0-10 pounds. The tester was applied to the peeled area of the pear and pressure applied until the plunger had penetrated 5/16 of an inch. Ten readings were made on the pears from each sample lot.

Christel Texture Meter readings were made with 57 g. of peeled and diced pears. Half-inch cubes were used. Five readings were made on each sample.

[a] No miticides were used because of the possible interference with the flavor of the finished product.

[b] Keese Engineering Co., Hollywood, Calif., Model UCD, 500 watts with blue filter.

Total titratable acidity. The remainder of the diced pears from the texture meter reading was disintegrated in a Waring blender for 30 seconds. Duplicate 10 g. samples of pulped pears were weighed into 250 ml. beakers and 200 ml. of distilled water was added. The resulting mixture was titrated with 0.1 N. sodium hydroxide until the pH value reached 8.0 in the Coleman Electrometer. The results were expressed as percent citric acid monohydrate.

Soluble solids. The soluble solids content of the pulped pears was determined by using a Zeiss Opton refractometer.

Ascorbic acid. Ascorbic acid content was determined by the 2,6-dichlorophenol indophenol titration method *(7)*. One hundred g. of the diced pear sample was mixed with 100 ml. of 6% metaphosphoric acid in a Waring blender for 20 seconds. Water redistilled through an all-glass apparatus was used in the preparation of the reagent. Then 50 g. of the slurry was weighed and diluted with 3% metaphosphoric acid to 100 ml. in a volumetric flask. After thorough mixing, the mixture was filtered through Whatman No. 1 filter paper. Then 20 ml. portions of the filtrate were titrated with 0.025% 2,6-dichlorophenol indophenol solution until the pink color that developed remained permanent for 15 seconds. The results are expressed as mg. of ascorbic acid per 100 g. of sample. The titer was standardized against C. P. ascorbic acid.

Tannin-like substances. Tannin-like substances were determined by the Folin-Denis reagent as described by Guadagni *(13)* and Pro *(21)*. It was modified to inactivate polyphenolases by metaphosphoric acid. One hundred g. of diced pears was blended with 50 ml. of 95% ethyl alcohol and 50 ml. of 6% metaphosphoric acid for 20 seconds in a Waring blender. Then 20 g. of the slurry was diluted with 70% ethyl alcohol to 100 ml. in a volumetric flask, and the contents were thoroughly mixed. The sample was filtered through Whatman No. 1 filter paper. Four ml. of the filtrate was pipetted into a 100 ml. volumetric flask containing 50 ml. of water and 5 ml. of Folin-Denis reagent. Twenty ml. of 1 M sodium carbonate was pipetted into the resulting mixture with vigorous agitation. The contents of the flask were diluted to 100 ml. and mixed thoroughly. The blue color that developed after 1½ hours was measured in a Klett-Summerson photocolorimeter, using a No. 66 red filter. Sometimes it was necessary to centrifuge for 5 minutes to remove the precipitated calcium carbonate. A blank was run on a mixture of the reagents. A standard curve for C. P. tannic acid was constructed, with concentrations ranging from 0.05 to 1.0 mg. of tannic acid per 100 ml. Since it was observed that ascorbic acid also gives a blue color with the Folin-Dennis reagent, the result of the tannin determination was corrected for ascorbic acid present in the sample. One mg. of ascorbic acid is equivalent to 0.80 mg. of tannin.

Volatile reducing substances. The amount of volatile reducing substances in canned Bartlett pears was determined by steam distilling a mixture of 50 g. of the pulped sample in 50 ml. of water. The distillate was collected directly into 20 ml. of 0.1 N. potassium permanganate in 1 N. sodium hydroxide. Any uncondensed volatile compounds were sucked through a sintered glass tube into a receiving tube containing 10 ml. of the same reagent. Both the receiving flask and the tube were cooled by ice water. Distillation was discontinued after 170 ml. of the distillate had been collected in about 30 minutes. The distillation was done under a slight negative pressure created by a water aspirator. The contents of the receivers were transferred into glass-stoppered Erlenmeyer flasks and kept in the dark for 30 minutes. Then 10 ml. of 5 N. sulfuric acid and 10 ml. of 30% potassium iodide were added to the flask. The iodine liberated was titrated immediately with 0.1 N. sodium thiosulfate, using 1% soluble starch as the indicator. A blank was run using 50 ml. of distilled water. Results were reported as micro-equivalents of potassium permanganate per 50 g. of sample.

Canning. The pears were peeled and cored in a Food Machinery and Chemical Corporation pear-peeler and then dipped into 1% sodium chloride solution for 2 to 3 minutes to retard browning. The quartered pears were trimmed and sorted before canning. Eighteen oz. of pears and 11 oz. of 25° Brix sucrose were weighed accurately (± 0.05 oz.) into each No. 2½ can. All cans were sealed under 15 inches of vacuum and cooked at 212° F. for 25 minutes in a rotary cooker. The processed cans were cooled rapidly in a cold water bath and then stored at room temperature.

Organoleptic evaluation. Three months after canning, the pears were appraised twice, on separate days, for color, general appearance, aroma, texture, and flavor. Six judges, experienced in judging quality, participated in the scoring. Duplicate cans of each sample were used. Each factor was graded on a 7-point scale, *poor* scoring 1, *fair* 4, *good* 7. A portion of each prepared sample was analyzed chemically by the methods previously described. The organoleptic evaluation was repeated 8 months after canning by the same 6 judges.

RESULTS

Storage of Bartlett pears at 34° F. To investigate the chemical and physical changes accompanying storage of Bartlett pears, fresh fruit at 20 pounds pressure test was held for 10 days at 34° F. Representative samples of pears were taken out at various time intervals for chemical analysis. The results are presented in Table 1.

The data indicate that the ripening process of green pears with an initial pressure test of 20 pounds was still proceeding at 34° F., although the rate was very slow. Within a period of 10 days, the pressure reading dropped from 20.4 pounds to 16.9 pounds. The Christel Texture Meter, which measures texture through a hydraulic multi-plunger type mechanism, indicated the same trend. Accompanying the drop in firmness of the fruit, there was a gradual decrease in total acid and ascorbic acid content. The ratio of soluble solids to total acid, which may also be used as a criterion for maturity, increased from 40.2 to 46.5. There was a slight increase in total solids, possibly caused by a loss of moisture to the atmosphere. The color change during this period of storage was much less than the change in firmness.

Changes accompanying ripening at 70° F. The pears stored at 34° F. for 10 days after harvest were ripened in a 70° F. room for different time intervals. Pears of the desired maturity as judged by pressure test and skin color were taken out at designated time intervals for chemical analysis and canning.

TABLE 1

Chemical and physical properties of Bartlett pears during storage at 34° F.

Time of storage at 34° F. in days	Total solids %	Soluble solids in ° Brix at 20° C.	pH	Total acid as % citric acid monohydrate	Ratio of soluble solids to total acids	Ascorbic acid in mg./100 g.	Skin color		Texture readings	
							Maerz and Paul color scale	Allen's color scale	Christel texture meter reading [1]	Pressure test in lbs.[2]
1	13.10	11.32	4.10	0.282	40.2	7.23	19K3–19K4	1.0–1.5	176.0±6.9	20.4±1.0
3	13.00	11.60	4.10	0.277	41.9	5.83	19K3–19K4	1.0–1.5	171.6±6.6	18.9±0.8
6	13.83	11.40	4.10	0.250	45.5	5.56	19K3–19K4	1.0–1.5	167.4±4.6	17.6±0.5
10	14.20	12.10	4.10	0.260	46.5	5.16	19K2–19K3	1.5–2.0	162.8±6.0	16.9±0.4

[1] Texture meter readings are the average of 5 readings.
[2] Pressure test readings are the average of 10 pears.

The data presented in Table 2 indicate a gradual increase of soluble solids content with maturation. This might be used as an auxiliary method for checking the ripeness of the fresh fruit prior to canning. The total titratable acidity decreased with maturation. When the pressure test of the fresh pears decreases to 4.9 pounds, the acid content apparently increases slightly accompanied by rapid softening of the pears. Possibly a new phase of physiological change begins at this stage. This point needs further investigation.

Ascorbic acid content gradually decreased with maturation. Tannin content also tended to decrease slightly during maturation. Color change was much more rapid when the pressure test dropped to below 4.9 pounds. The green skin color decreased whereas the yellow color increased with maturation. However, Claypool and co-workers *(10)* suggest that color difference alone is not a reliable criterion for maturity of Bartlett pears, as the tissue may remain hard even after the pears have turned yellow if they have been kept long in storage at low temperature and thus lost ripening capability *(1)*.

Firmness of the pears decreased with maturation. At the present time, the pressure test is still a widely used method for approximate evaluation of maturity of Bartlett pears both in the field and for canning. Table 2 indicates that tissue softening during maturation was more pronounced than the changes in soluble solids, titratable acid, or ascorbic acid content. It is interesting to note that the Christel Texture Meter failed to register any reading on samples that read 2.6 and 1.1 pounds by the pressure tester. The dicing operation used to sample the pears for the Christel Texture Meter reading may have caused this difference. It has been pointed out by Allen *(1)* that Bartlett pears grown at different localities in California may differ in pressure test, yet yield the same dessert quality. Thus, pressure test alone may not be the perfect means of ascertaining the maturity range of pears before canning.

Influence of maturity on organoleptic quality of canned Bartlett pears. Although numerous studies have dealt with the maturity and storage of Bartlett pears for fresh market *(1, 19)*, little information is available regarding the influence of fresh pear maturity on acceptance of the canned product. In this investigation, pears at different stages of maturity as judged by pressure test, color, and soluble solids were canned in 25° Brix sucrose syrup and then stored at room temperature for 3 months to allow exchange of constituents between the fruit and the syrup. The canned pears were then tested for organoleptic quality in our acceptance laboratory. The data are presented in Table 3.

In general, pears with an average pressure test of 4.9 pounds did not achieve as high a score in aroma and flavor as those with a lower pressure test. Those with an average pressure test of 2.55 pounds yielded a canned product of the highest score in general appearance and texture. Maximum scores for flavor and aroma were obtained from pears with an average pressure test of 1.5 pounds, although their scores for texture and general appearance were lower. Pears with an average pressure test of 1.1 pounds were graded as overripe because of their lower scores in aroma and flavor. These results suggest that fresh pears with average pressure ranges of 2 to 3 pounds immediately before peeling may be considered as most suitable for canning. Although it is not feasible to can pears of exactly the same pressure test, every effort should be made to bring them to uniform and optimum maturity before canning. This can be done through a controlled ripening process even though pears ripen and soften rapidly after reaching 5 pounds pressure test.

The range of flavor difference among these samples of canned Bartlett pears due to the variation in maturity of the fresh pears was significant at the 2% level (in other words, there is a 98% probability that the difference between the highest and lowest scores could not be due to chance), and the difference in aroma was significant at less than 1%. No significant difference in texture was observed. Although as the pears mature their texture tends to soften rather rapidly, their texture acceptability apparently does not change. Flavor and aroma improve until the overmature stage is reached. Both color and general appearance showed highly significant differences, with the highest score going to those pears with a pressure test of 2.55 lbs. From the viewpoint of the canner, the color and general appearance of canned pears play as important a role as flavor and aroma in evaluation of quality. Thus, a compromise stage of maturity must be chosen that will give the most satisfactory product. This stage may vary with the climate and soil condition of the locality where the pears are grown, and also with the handling of the fruit after harvest.

Chemical analysis of the canned pears. The chemical analysis of canned Bartlett pears of different maturities is presented in Table 4. The slight increase in total titratable acidity that occurred during the ripening of fresh pears below 4.9 pounds pressure test is also reflected in the canned product. This increase in acidity

TABLE 2

Physical and chemical changes accompanying ripening of Bartlett pears at 70° F.[1]

Time of storage at 70° F. in days	Total solid %	Soluble solids in ° Brix at 20° C.	pH	Total acid as % citric acid monohydrate	Ratio of soluble solids to total acids	Ascorbic acid in mg./100 g.	Tannin mg./100 g.	Skin color		Texture readings	
								Maerz and Paul color scale	Allen's color scale	Christel texture meter reading	Pressure test in lbs.
1	.....	11.89	4.10	0.258	46.0	5.30	43.0	19K2–19K3	1.75	164.8±7.7	16.2±1.3
2	14.45	12.97	4.10	0.261	49.7	5.10	42.3	19K2–19K3	1.75	124.0±8.2	14.3±1.9
3	.....	12.84	4.15	0.254	50.6	4.63	43.3	19K1–19K2	2.50	82.2±5.5	8.0±2.1
4	14.54	13.20	4.10	0.237	55.7	4.26	38.0	19K1–19K2	2.50	51.8±7.3	**4.9±1.5**
5	.....	13.80	4.10	0.250	55.2	3.52	37.2	19K1	3.0	0	2.6±0.6
6	14.00	13.41	3.90	0.291	46.1	2.19	36.5	18J1	4.0	0	1.1±0.5

[1] The pears were stored at 34° F. for 10 days before entering the 70° F. room.

TABLE 3

Organoleptic evaluation of quality of canned Bartlett pears [1]

Sample No.	Pressure test of fresh pears prior to canning in lbs. of pressure [2]	Color	Organoleptic scores of canned Bartlett pears [3]			
			General appearance	Aroma	Texture	Flavor
202-1	4.90±1.50	4.58± .86	4.58± .76	3.58±1.02	3.92±. 95	3.33±1.79
202-7	2.55±0.60	5.58± .95	5.92± .64	4.25±1.04	4.92±1.46	3.25±1.23
202-4	1.65±0.23	4.25± .83	3.92±1.18	4.50± .91	4.33±1.12	3.42±1.37
202-8	1.50±0.37	3.92±1.18	3.92±1.32	5.83± .90	4.67±1.49	5.58±1.08
202-2	1.10±0.51	4.75±1.29	4.33±1.24	4.50±1.11	4.42±1.11	4.42±1.18
Probability that there is no significant difference between highest and lowest scores *(24)*		>1%	<1%	<1%	>5%	2%

[1] The taste panel consisted of six experienced judges. Each factor was graded on a seven-point scale, 1 scoring *poor*, 4 scoring *fair*, and 7 scoring *good*.
[2] Texture of fresh pears was measured by plunger type fruit pressure tester, with pressure readings ranging from 0-10 pounds.
[3] Scores are averages of evaluations 3 months and 8 months after canning.

might be related to the improvement in aroma and flavor during the second phase of ripening. The nature of chemical and physiological changes accompanying this stage of maturation is not known. Less ascorbic acid was present in the more mature fresh pears, and this trend is sustained in the canned product.

There is an interesting correlation between the maturity of the fresh pears and the volatile reducing substances in the canned product. As the pears matured, their volatile reducing substances increased while the pressure test decreased to 1.5 pounds. The sample that scored highest in aroma and flavor had the highest content of volatile reducing substances. Thus the volatile reducing substances content might provide measurement for evaluating flavor and aroma of canned Bartlett pears.

The chemical, physical, and organoleptic anaylses of a similar series of pears of different maturities (pressure test) were repeated in 1953. All of the data were in close agreement with the observations made in 1952.

SUMMARY

The effects of storage at 34° F. and ripening at 70° F. of Bartlett pears harvested at 20 pounds pressure test on their chemical and physical properties were investigated. When stored at 34° F., ripening still proceeded, although at a much slower rate than at 70° F. Accompanying maturation, there was a gradual increase in soluble solids content and a decrease in pressure test and ascorbic acid and tannin content. Acid also decreased with maturation except in the later stages.

Pears ripened to different degrees of maturity, as judged by the pressure test, color and soluble solids content, were canned in 25° Brix sucrose syrup and then stored for 3 months to allow exchange of constituents between the fruit and the syrup. A selected number of samples canned from fresh pears at average pressure tests ranging from 4.9 to 1.1 pounds were evaluated for texture, color, general appearance, aroma, and flavor. The difference in flavor among these samples due to the variation in maturity of the fresh fruit was significant at the 2% level, whereas the difference in aroma was significant at less than 1%. No significant difference in texture was observed. These results show that fresh Bartlett pears with average pressure test of 2 to 3 pounds immediately before peeling were best suited for canning.

There is a very interesting correlation between the maturity of fresh pears as measured by pressure test and the amount of volatile reducing substances in the canned product. As the pressure test of the fresh pears decreases, the volatile reducing substances in the canned product increase. Canned Bartlett pears scoring highest organoleptically in flavor and aroma had highest volatile reducing substances content. Chemical analysis of volatile reducing substances promises to provide an objective criterion of aroma and flavor of canned Bartlett pears.

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TABLE 4

Chemical analysis of canned Bartlett pears of different maturities

Sample No.	Fresh fruit	Canned fruit					
	Texture prior to canning, in pounds	pH	Soluble solids in ° Brix at 20° C.	Total titratable acids as % citric acid monohydrate	Ascorbic acid in mg./100 g.	Tannin in mg./100 g.	Volatile reducing substances in micro-equiv. $KMnO_4$ per 50 g. sample
202-1	4.90±1.50	4.19	17.07	0.179	0.26	25.0	278.0
202-7	2.55±0.60	4.19	17.07	0.183	0.16	25.5	370.4
202-4	1.65±0.23	4.12	17.00	0.194	0.13	24.0	457.6
202-8	1.50±0.37	4.11	17.07	0.197	0.13	27.2	514.0
202-2	1.10±0.51	4.10	17.17	0.191	0.13	23.0	406.3

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Notes and Letters

Surface Darkening and Iron Content of Glass-Packed Foods

Livingston, Solstad, Vilece, and Esselen in the July issue of Food Technology in their article, "The Role of Trace Metal Contamination in the Discoloration of Glass Packed Baby Foods," state:

> "Findings published by Kohman and Cole on the distribution of iron in samples of storage-darkened soups in baby food jars have led to the speculation that the higher iron content in the upper portion of the product was due to the diffusion of retort water into the jars during processing."

Since the authors do not indicate that our work is a comparison of aluminum caps (no source of iron) with tin plate caps this does not reflect the data given in our paper and the inference that we drew from that data. We did show that increased iron content in the surface food is at times the primary factor in surface discoloration and data that Livingston et al. present confirm this. About that there seems to be no doubt or disagreement. This has been recognized with other foods before baby foods were packed.

But that entrance of iron-containing retort water diffusing through the seal during processing is generally an outstanding source of such iron is not borne out by our data. It is merely a possibility. Our data clearly show that corrosion of tin plate caps is the primary source of the higher iron content of the surface food. But in a few instances with aluminum caps the surface food was also discolored (darkened), and there too the surface food had a significantly higher iron content. Three possible sources of this iron were given and diffusion of iron contaminated retort water through the seal during processing and cooling seemed to us the most probable. That such seepage is possible and does occur under certain conditions is no original observation on our part. In our paper we bring out that in the smaller packs with aluminum caps there was no surface darkening and no higher iron content in the surface food when we held the caps on with clamps and processed in steam.

Livingston et al. have done a commendable service in the survey they have made of iron in retort water. Its low concentration renders it useless to measure seepage of retort water through the seal. They point out the high contamination of retort water necessary to account for the iron we observed in a few instances with aluminum caps. We were perhaps negligent in not calling attention to the fact that for our work involving the larger pack with aluminum caps a retort had to be specially equipped for processing under water with air pressure, which might be expected to result in far more rust being suspended in the small amount of water necessary to cover our relatively small pack than in retorts in regular use.

It is appropriate also to call attention to the vastly improved performance of caps and gaskets now in use. Perforations are rare as compared with what was the condition when we made our original report [*Ind. Eng. Chem.*, **42**, 1578 (1950)], when every packer of baby foods encountered perforations probably beyond any precedent in the whole preserving industry. Cap manufacturers are to be commended for this progress, once the reason for the difficulty was understood.

E. F. Kohman
Consultant
Campbell Soup Company
Camden, New Jersey

LOOK INTO THE GLEAMING, clean interior of a Stainless Steel rotary washer. Apples are tumbled under a stream of water at an early stage in preparation. The washer was fabricated by Leitelt Iron Works, Grand Rapids, Mich.

when baby foods have to be babied

Gerber

FINDS YOU CAN'T BEAT STAINLESS STEEL

THIS STAINLESS STEEL VOTATOR is used for rapid sterilization and cooking of such acid products as apples, peaches and pears. This continuous closed heat transfer process equipment was manufactured by Votator Division of the Girdler Corporation, Louisville, Ky.

"BABIES are the most important people" to Gerber Products Company, Fremont, Mich. That's why protection of quality and purity comes in for such close attention in processing Gerber's Baby Foods. And that's why Stainless Steel holds down so many vital spots in the production line.

As food in process passes through the receiving, preparation, kitchen, cooking and canning departments, about the only thing it touches is Stainless Steel. That's because Stainless Steel has such superior corrosion resistance . . . because it is unaffected by food acids and prevents contamination of the product . . . and because its ease of cleaning makes "housekeeping" so much easier.

Stainless Steel equipment at Gerber's includes steam peelers, rotary washers, trim bins, work stations at the picking belts, screw steamers, hammer mills, finishers, holding tanks and filling machines.

If your operations call for equipment that is easy to clean and easy to keep clean . . . equipment that resists corrosion . . . equipment that lasts and lasts, Stainless Steel is the logical choice. But be sure it is perfected, service-tested USS Stainless Steel, made to give you the finest performance.

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Our Nominee for SALES MANAGER of the Month

JERRY SCHARER,

Sales Manager, Star-Kist Foods, Inc.
Terminal Island, California

An outstanding combination of sales ability, imagination, merchandising know-how and progressive thinking has raised Mr. Scharer to his position of national prominence in sales management.

"No salesman is better than his product," says Mr. Scharer. "And in packaged food, no product is better than the flavor it offers the consumer. Flavor is the one ingredient that is absolutely essential to every processed food."

Yes, flavor is vital to sales success

Nothing is more important to steady food sales than *steady food flavor*. It's what makes satisfied customers. Satisfied customers are what make *first* sales lead to *repeat* sales!

Top-level food processors take no risks in their operations – they guarantee *flavor* with Ac'cent!

Ac'cent – pure monosodium glutamate – is the natural seasoning that builds flavor in all foods ... meats ... fish ... poultry ... vegetables. Ac'cent restores the fresh, natural flavor food had in its original state, then intensifies that flavor and keeps it – through processing – freezing – canning. Food gets to the consumer with all its natural goodness locked in!

Ac'cent retards loss of color, of texture, of moisture, too. Yet Ac'cent adds no flavor, color or aroma of its own. Try Ac'cent in your food processing.

HELP FOR THE ASKING

Our staff of 75 specialists is ready to assist you with your technical problems. If we can be of help, do not hesitate to write us.

makes food flavors sing

Ac'cent®

PURE MONOSODIUM GLUTAMATE

AC'CENT INTERNATIONAL, 20 N. Wacker Drive, Chicago 6, Ill.

good ideas have no "office hours"

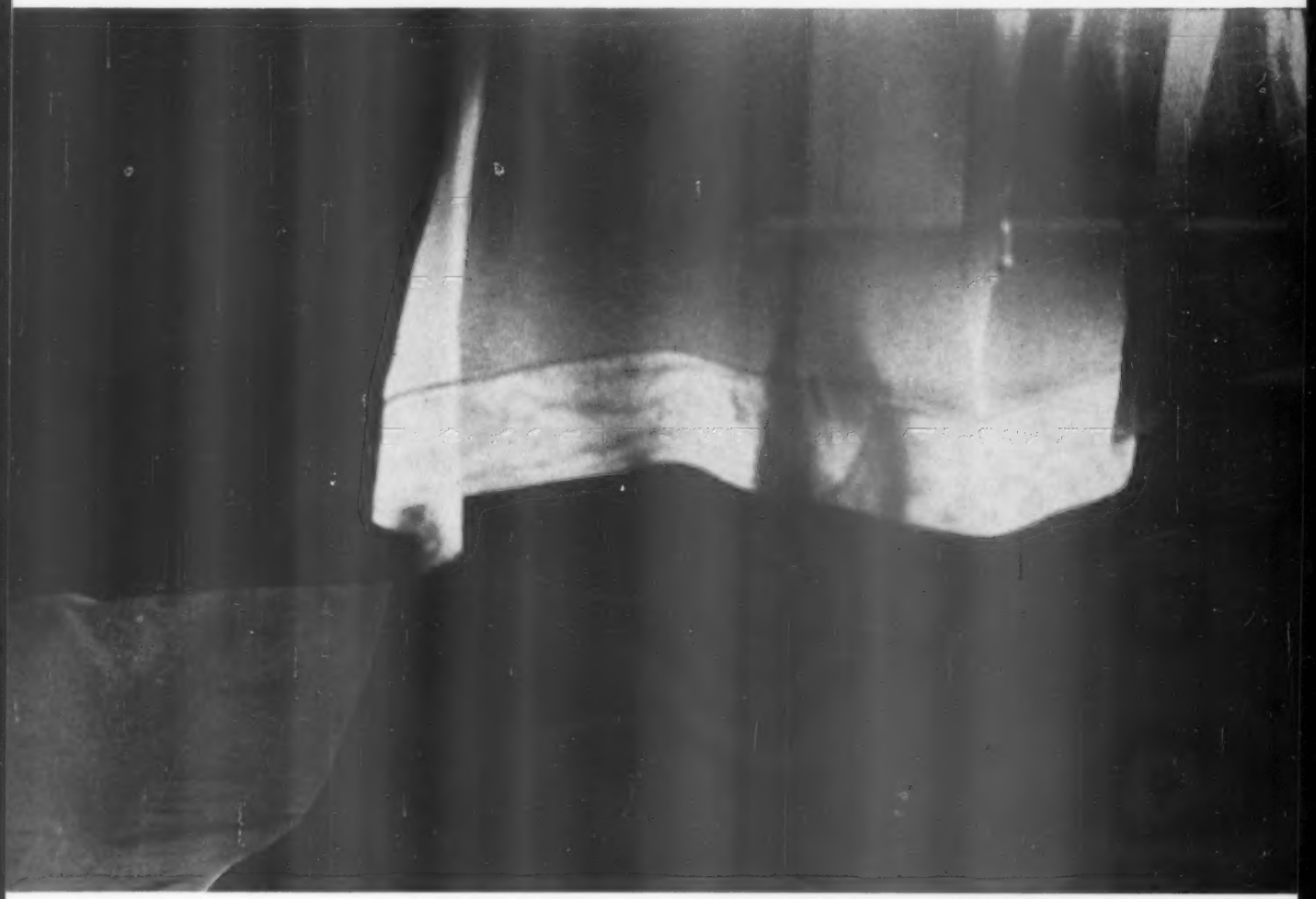
Here are ways Pfizer products are now being used to improve processing methods, or to

Vegetable fat frozen desserts gain substantial sales appeal when fortified with Pfizer Vitamin A. Nutritionally, these fortified, low cost desserts stand up favorably against more expensive desserts, giving the budget-minded, vitamin-conscious housewife the kind of product she's looking for. Moreover, Pfizer Vitamin A fortification costs as little as *a quarter cent* per gallon of vegetable fat frozen dessert.

Edible oils stay fresher longer—are protected against undesirable off-flavor, aroma and color—when processors retard oxidation with Pfizer Citric Acid. Under Standards of Identity for salad dressings, mayonnaise and similar products, Citric may replace part of the vinegar. The benefits gained are two-fold: the Citric cuts material costs and sequesters trace metals which promote rancidity.

That's why your Pfizer sales representative really lives with your problems

Good ideas don't come easily. Especially when you're wrestling with such food processing problems as *how to cut plant operation costs... increase product sales appeal... create new food products.* This requires more than a little solid thinking and "midnight oil burning." Isn't it a wise step, then to have the trained, experienced mind of a good salesman working on your problems, too? Your Pfizer sales representative welcomes this challenge. Why? Because his success is directly related to helping achieve your successes. And to back him up and stimulate his thinking he has the Pfizer Technical Service Department and all the vast experience Pfizer has gained in working with the food processing industry for nearly a century. Why not put this thinking and experience to work for you?



add sales appeal to foods and beverages.

In fruit and vegetable juices, Pfizer Ascorbic Acid plays an important part as an antioxidant in protecting color and flavor. In combination with Pfizer Citric Acid—Ascorbic economically and effectively helps prevent browning of frozen peaches and other fruits. In the brewing of light beer and ale, Ascorbic Acid retards development of off-colors and flavors resulting from exposure to light and air.

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Whenever you have a food processing problem, talk it over with your Pfizer sales representative. He'll be glad to assist you.

Diamond Crystal Alberger Salt is

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**The premium grade salt used by food processors.*

FOOD TECHNOLOGIST AT YOUR SERVICE

For free consultation on choice and application of the right salt for your food products—call, wire or write:

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FOOD INDUSTRY TOPICS

(Continued from page 24 preceding technical papers)

as well as public health officials, regulatory officers, food technologists, and students of the food and drug industry. Sanitary techniques will be reviewed and demonstrated with seminar discussions of specific problems relating to food and drug processing. Each of the three units of the course will cover 12 weeks, one night per week. Tuition is $45 for each unit, plus a $5 registration fee for the three units. Enrollment requirement is identification with the food and drug industry.

◆ ◆ ◆

Business "Oscars" were given by the Free Enterprise Awards Assn., Inc., New York City, on August 4 to six American businessmen who achieved their success the hard way. The presentation was made by Mr. Talbot T. Speer (far left), editor and publisher and chairman of the FEAA's selection committee. Recipients were, from left: Mr. Clarence C. Crispen, president of the Inclinator Company of America; Mr. Alfred Ananabaum, president of Tanbro Fabrics Corp.; Mr. Robert S. Graves, president of Louis L. Libby Food Products; Mr. Herbert Abraham, president of Ruberroid Co.; Mr. Earl Katz, president of Katz Drug Company, accepting for Isaac and Michael Katz, founders; and Mr. Ambrose E. Stevens, vice president, Minute Maid Corp., accepting for Mr. John M. Fox who started the frozen concentrate industry.

◆ ◆ ◆

The Association of Food Industry Sanitarians announces formation of three new local sections. They are: The Golden Gate Section, which covers the San Francisco area, with Mr. Rolie O'Neal as president; The Southern California Section, covering the Los Angeles area, with Mr. C. R. Sutherland as president; and the New York Section, with Mr. Chas. A. Clark as president. Anyone interested in the aims and goals of the Association, or its local sections, is encouraged to write to Mr. Lloyd Fox, president of the organization, c/o Exchange Orange Products Co., Ontario, Calif., or to the executive secretary, Mr. E. S. Doyle, 1950 Sixth St., Berkeley 2, Calif.

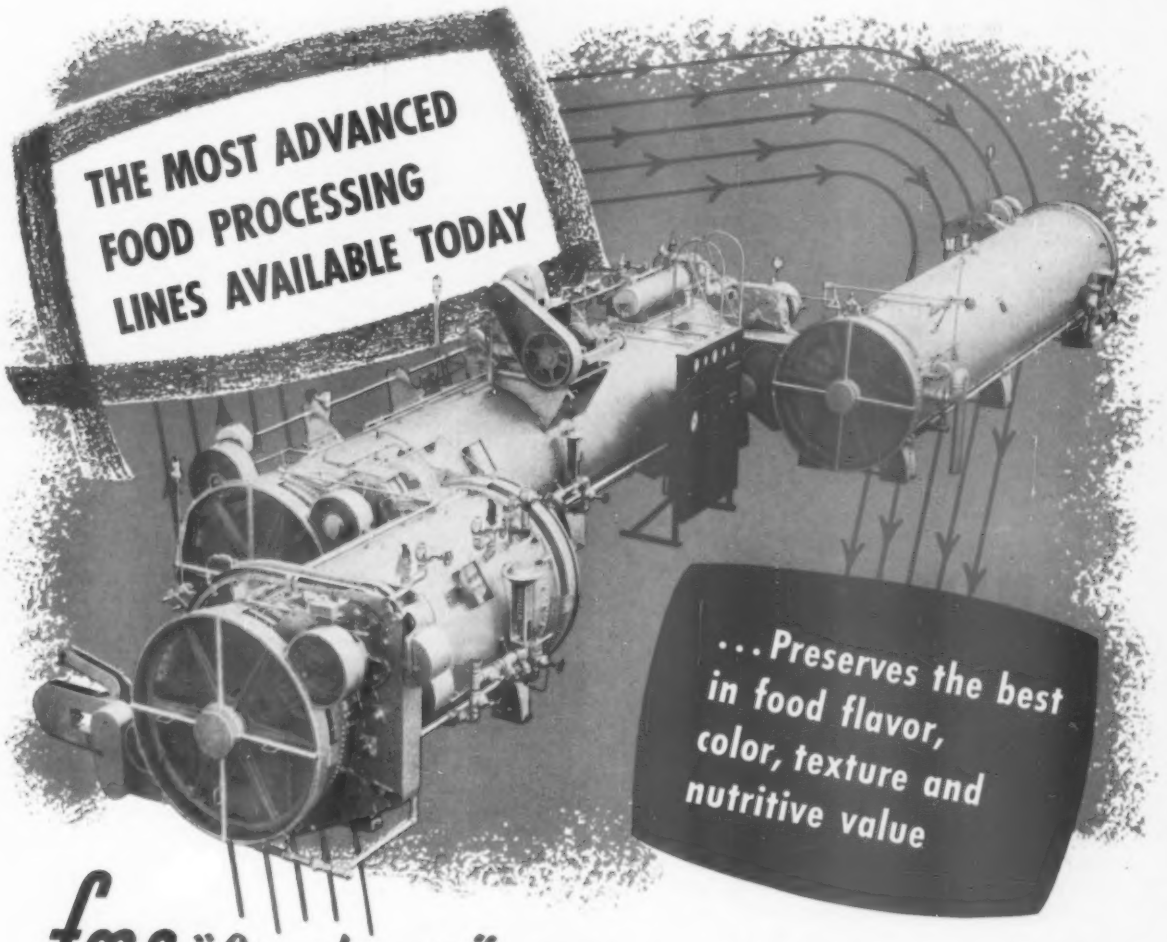
◆ ◆ ◆

"Eating the right foods will add years to your life and life to your years." This is the theme of a **dramatic new educational exhibit,** "Food for Life," in the Museum of Science and Industry, Jackson Park, Chicago. The exhibit, a public service contribution by Swift & Company, portrays the extent of man's knowledge of foods. Mr. John Holmes, president of Swift, points out that the exhibit provides basic information to guide visitors in selecting their daily diets. Major L. R. Lohr, Museum president, cites the exhibit as marking the first time the nutrition story has ever been told in a Museum on such a large scale. Almost two million people are expected to see the exhibit annually.

◆ ◆ ◆

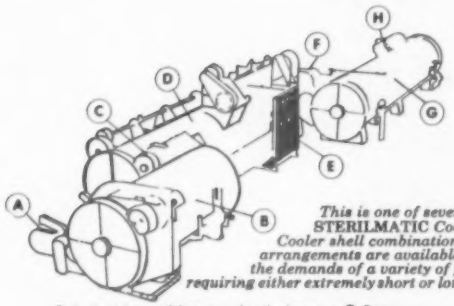
Grants totaling $2,176,904.71—made possible by gifts from business and the medical profession—were awarded July 19 to the nation's 80 medical schools by the National Fund for Medical Education, Mr. S. Sloan Colt, president, announced. Each of the 74 four-year schools received $15,000 plus $25 per undergraduate medical student, while each of the six two-year basic sciences schools received $7,500 plus $25 per student. Mr. Colt said that business corporations contribute through the Fund's Committee of American Industry, while doctors give through the American Medical Education Foundation, set up by the American Medical Assn. He stated that Fund grants which are unrestricted are used by the schools primarily to fill teaching vacancies, to create new faculty posts, and to initiate courses in areas of recent scientific advances. This year's

(Continued on page 32)



fmc "Sterilmatic" PRESSURE COOKER and COOLER

Trade Mark



This is one of several FMC **STERILMATIC** *Cooker and Cooler shell combinations. Other arrangements are available to meet the demands of a variety of products requiring either extremely short or long cooks.*

A Left side positive cup-feed elevator, **B** Pressure pre-heater, **C** Pre-heater discharge valve, **D** Pressure cooker, **E** Central control panel, **F** Micro-cool valve, **G** Atmospheric cooler, **H** Discharge turret.

High-speed *STERILMATIC* Cooker and Cooler lines give canners the *precise processing control* needed to maintain their high standard of product quality and uniformity. This continuous, automatic equipment cooks every can *evenly*—cooks every can *exactly alike*. The natural flavor, color, texture and essential vitamins of farm-fresh fruits and vegetables are protected and preserved at their peak of harvest perfection. And these qualities last, too—locked in to be fully enjoyed when the can is opened and the product served. Write for full information on FMC's outstanding "one-man cook room," or call your nearest FMC representative.

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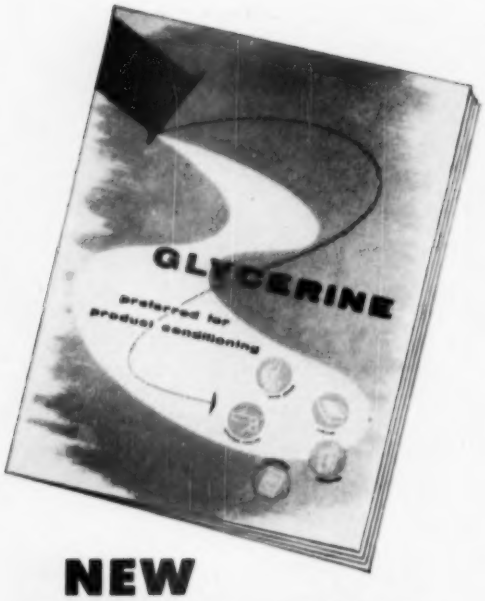

NEW
20-page booklet on
PRODUCT
CONDITIONING

Would your product be improved by better protection against hardening or drying out? Or by longer-lasting flexibility, softness, or controlled viscosity? Then this new booklet will be helpful to you. It discusses the technical aspects of product conditioning, and contains text, tables, and graphs that will help you select a product conditioning agent. Here are some of the subjects covered:

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Nothing takes the place of Glycerine

FOOD INDUSTRY TOPICS

(Continued from page 30)

grants bring to $6,941,057.35 the total awarded to medical schools by the Fund since 1951 when its first awards were made.

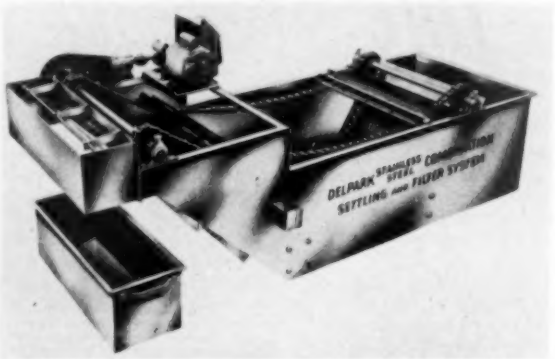
◆ ◆ ◆

In recognition of the increased use of radiation and the associated health protection problems, the Public Health Service, U. S. Department of Health, Education, and Welfare, sponsors a **radiological health training program.** Purpose is to indoctrinate public health workers with the significance of ionizing radiations, the environmental and occupational hazards attendant on their use, and recommended procedures for minimizing such hazards. The training program, presented at the Robert A. Taft Sanitary Engineering Center, Cincinnati, O., is designed primarily for professional personnel of State and local health departments, but a limited number of qualified applicants from other governmental agencies and industry will be welcome. For further information address: Chief, Radiological Health Training Section, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, O.

◆ ◆ ◆

Fiber containers, one of the packaging field's most economical and efficient means of marketing many food and non-food products, have grown into a **$55,000,000-a-year industry business,** reports American Can Company, New York City. "This volume—a four-fold gain since 1940—does not include sales of the industry's annual production of ten billion paper milk containers," Mr. D. B. Craver, Canco's vice president in charge of sales, stated. At present, six of the can company's 59 factories are equipped to furnish a wide assortment of types, shapes, and sizes—round, oblong, or square; short, medium, or tall; with or without metal ends and with different types of closures. "The diversified fiber container holds a unique position in the packaging industry," Mr. Craver stated. "It has distinct advantages over the many containers it has replaced for it combines much of the rigidity of metal and glass, it is non-transparent, resistant to vapors and odors, and yet comes within certain economic limitations of container-users."

. . . *things new under the sun*



Delpark Settling and Filter Systems fabricated of stainless steel are now available for the filtration of liquids which would be affected by other types of metals. Basic applications of this filter are in the food processing industry for the filtration of edible oils and juices and in the papermaking industry. Designed for the filtration of particles .004" or larger, the System makes use of a settling basin for the removal of particles of varying weights prior to filtration through special bar stock screens. For further information, write to Mr. Geo. L. Guyman, vice president, Industrial Filtration Co., Dept. SS-504, Lebanon, Ind.

◆ ◆ ◆

Differing from conventional packaging units, the "Wrap-Trap" bag packaging unit, manufactured by Triplex Industries, Inc., Riverdale, Ill., functions in a continuous straight-line operation. Once the machine is started, the motion is uninterrupted throughout the forming, filling and sealing operations, thus eliminating the usual wear and tear caused by repeated stopping and starting. The new machine handles vir-

(Continued on page 34)

Sterwin offers

"TRIPLE" SERVICE

to help the food industry produce better products

1

Products and Delivery

Most complete line of Vitamins, U.S.P., Vanillin, U.S.P., Certified F.D.&C. Colors. Any quantity—when you want them—where you want them. Quick delivery from branches in 11 cities covering the United States and Canada.

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Subsidiary of Sterling Drug Inc.

1450 BROADWAY, N. Y. 18, N. Y.

FOOD INDUSTRY TOPICS

(Continued from page 32)

tually all modern heat sealing materials such as aluminum foil, saran, and polyethylene laminations, coated papers, etc. The "Wrap-Trap" is covered by a unique guarantee. Prior to acceptance of an order, Triplex tests the machine in action. When the machine has demonstrated that it can do the job, Triplex guarantees, in writing, the rate of production agreed upon with the customer.

◆ ◆

Rhodia, Inc., announces the commercial availability of a **new industrial reodorant** for airborne odor abatement in the canning industry and the wholesale market field. The product, designated "Alamask" CPM-X, was developed after years of laboratory tests and use in canneries and wholesale markets, and has proved successful in combating the obnoxious odors caused by products of nitrogenous decomposition. For complete information on "Alamask" CPM-X, write to Rhodia, Inc., Industrial Reodorants ("Alamask") Division, 230 Park Ave., New York 17, N. Y.

◆ ◆ ◆

A compact new portable wireless intercom system that plugs into any standard 120-volt A.C. or D.C. outlet simplifies office-to-shop, stockroom-to-sales floor, interdepartment communication, inventory taking, etc. Two-way communication is possible between two, three, or four persons in separate departments or buildings. Over-all size is 8¼" x 5 ⅝" x 6". A complete two-station system is priced at $66.90, and additional stations are $33.45. Manufactured by General Industrial Co., 5738 N. Elston Ave., Chicago, Ill.

◆ ◆ ◆

An aid for busy people in home, office, or factory, "Telehold," manufactured by American Homecraft Co., 3714 N. Milwaukee Ave., Chicago 41, Ill., allows a person to do telephoning while keeping hands free. Made of lustrous black plastic with foam rubber padding on the resilient shoulder piece, it adjusts automatically to all shoulder widths and slopes and is attached to the phone without use of tools. Price is $1.98 postpaid.

◆ ◆ ◆

Maintenance and safety engineers will be able to test Pennsalt NeoFloor, **the new industrial, skid-proof surface** introduced by the Pennsylvania Salt Mfg. Company earlier this year, without guesswork as to quantity of materials needed for a complete job. A trial kit, sufficient to surface an area of 30 square feet, is now available through the authorized representatives of the company's Corrosion Engineering Products Dept. NeoFloor has reportedly given excellent results in plants where oils, greases, and chemicals create safety hazards. The trial kit, selling for $15, can be obtained from the Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia 7, Pa.

◆ ◆ ◆

AiroViber Rotary Vibration, manufactured by Viber Co., 726 S. Flower St., Burbank, Calif., moves bulk materials by **breaking up arching and jamming** in bins, hoppers, chutes, feeders, and other places where bulk materials hang up. It is recommended for loading, unloading, moving, packing, processing.

(Continued on page 36)

Check 2 New Griffith Antioxidants for

More Oxidative Stability For More Foods At Low Cost . . . . . .

Compare the Performance of these Formulas with that of Any other Antioxidant

Shortening • Lard
Fish • Chicken
Peanut Oil • Olive
and other Vegetable Oils • Citrus Fruit Flavors and Essential Oils

	"G-15"	"G-16"
Highly effective in retarding oxidation for long period in low concentration	YES—Contains Propyl Gallate	YES—Contains Propyl Gallate
Excellent "carry-through" stability after exposure to high (baking) temperatures	YES—Contains BHT and BHA	YES—Contains BHT and BHA
Non-toxic	YES	YES
Imparts no flavor, odor, or color	YES	YES
Develops no flavor, odor, or color during its stabilizing life	YES	YES
Doesn't cause metal-reactive discoloration of product	YES—Contains Patented* Lecithin-Citrate	YES—Contains Monoglyceride-Citrate
Oil-soluble	YES	YES
Water-soluble	—	YES
Reasonable in cost	YES	YES
Packed in convenient non-returnable drums	YES	YES

We'll be glad to consult with you in selecting the proper antioxidant for most effective and economical stabilization of your products. Write us.

*U. S. Pat. No. 2,677,616

THE Griffith LABORATORIES, Inc.

IN CANADA—THE GRIFFITH LABORATORIES, LTD.
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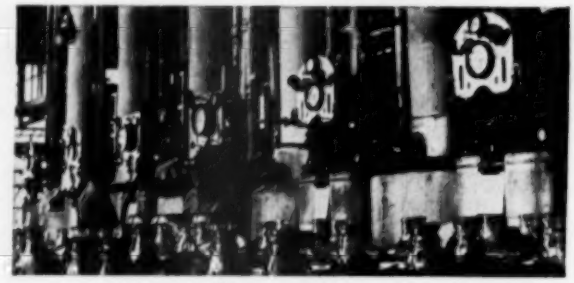
Laboratorios Griffith do Brasil, S.A.—Caixa Postal 300 Mogi das Cruzes, Sao Paulo, Brasil

Givaudan

produces



basic

flavor materials

As a primary source of supply for flavor materials, Givaudan, the world's largest producer of aromatics, has played a dominant role in the development of flavoring science.

We offer you a complete line of flavors for confectionery, ice cream, bakery and other products—all skillfully created to lend true taste appeal. At your request, our flavor staff will study your individual problem and make recommendations from hundreds of proven Givaudan flavors. Or we will develop an individual creation to meet your specific needs. Make Givaudan your flavor headquarters.

Givaudan Flavors Inc.

330 West 42nd Street, New York 36, N. Y.

Branches: Philadelphia • Boston • Cincinnati • Detroit
Chicago • Seattle • Los Angeles • Toronto

FOOD INDUSTRY TOPICS

(Continued from page 34)

grading, or separating materials. It can also be used for vibrating tables or platforms, sorting, and many other applications. AiroViber has only one moving part (a steel ball), performs at high or low temperatures, and does not require lubrication or periodic maintenance.

◆ ◆ ◆

DriAire, Inc., South Norwalk, Conn., sends word concerning its line of **moisture control devices.** DriAire Humi-Caps are small, one-piece, transparent, plastic dehydrators produced in three sizes. DriAire Humi-Spots are cards impregnated with spots of moisture-sensitive material showing different degrees of relative humidity. DriAire Humi-Eyes are external indicators that show humidity within a barrier package. DriAire Dehydrator Plugs control moisture inside equipment such as aircraft components, optical and electronic devices, and reciprocating engines.

◆ ◆ ◆

A new and improved filter and drier unit which reportedly adsorbs 98% more moisture than others previously manufactured has been announced by A-P Controls Corp., Milwaukee, Wis. Guaranteeing a greater degree of safety to every application, and eliminating corrosion and dirt problems created in the refrigeration system, the new Trap-Dri also (1) adsorbs harmful acids, (2) provides depth filtration, (3) prevents chemical reaction in system, and (4) operates at no appreciable pressure drop. Write A-P Controls Corp., 2450 N. 32nd St., Dept. A., Milwaukee, Wis., for further information.

◆ ◆ ◆

Rigid aluminum foil containers are now being produced in color for the first time by Ekco Products Company, 1949 N. Cicero Ave., Chicago. The containers are available in four stock sizes and in red or green striped patterns. They are suited for holiday and year-round packaging of baked goods, frozen foods, dairy products, confections, and restaurant take-out orders.

◆ ◆ ◆

A new, exceedingly low-toxicity solvent for cleaning wax, oil, or grease from food machinery is available from Teet, Inc., Cortland Ave. and Erie St., Dumont, N. J. Known as "Vythene-C," the solvent is less than 1/20th as toxic as Carbon Tetrachloride, yet fast evaporating and has no flash point or fire point.

. . . *the literary corner*

A 28-page guide to assist science educators, researchers, laboratory technicians, and other microscopists in selecting the microscopes and accessories to meet their specific needs has been produced by Bausch & Lomb Optical Co., 635 S. Paul St., Rochester 2, N. Y. Uses, performance data, and specifications on more than 60 different microscope models and accessories are outlined in the brochure, "Bausch & Lomb Dynoptic Laboratory Microscopes," Booklet D-185, available by writing the company.

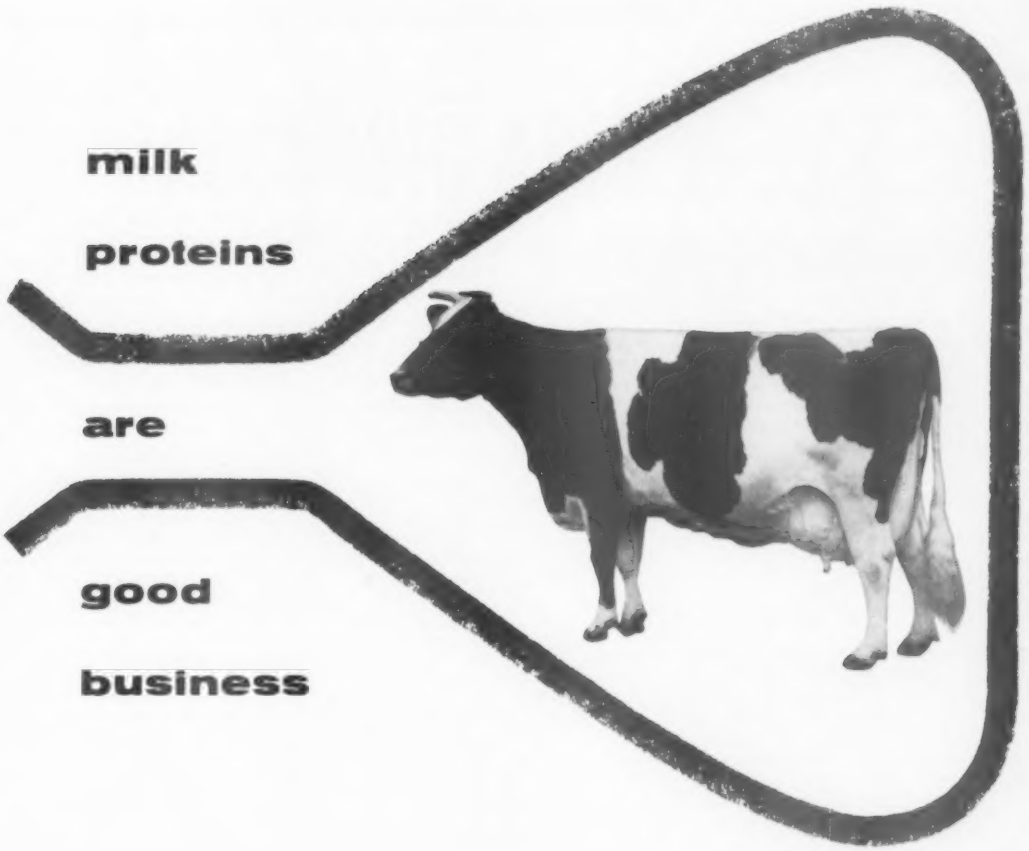
◆ ◆ ◆

An absorbing 8-page, two-color brochure has been produced by the Canada Department of Agriculture highlighting its Dairy Technology Laboratory, Central Experimental Farm, Ottawa, Canada.

◆ ◆ ◆

Applications, operation, and features of the Dura-Mil Liquid Filler are described in a new 4-page bulletin. A rotary, gravity-

(Continued on page 38)



Today, the public is becoming more and more aware of the need for lower calorie, tissue building, higher protein containing foods for everyone, particularly grownups and the ever-expanding old-age groups. Processors of food products can cash in on this interest by increasing and improving on the protein content of their products with Sheffield milk proteins.

Ice cream, baking, cereal, infant food and meat processors are finding milk proteins a highly desirable supplement to their products. Nature has built extra values into milk proteins, and Sheffield brings these extra values to you. As an example, Sheffield milk proteins are outstanding in nutritional quality because of the fine balance of all essential amino acids.

Sheffield guards the quality of its milk proteins through complete control of the process from farm-fresh milk to the finished product . . . and Sheffield makes these proteins available to you in a wide variety of forms, with characteristics to suit your needs.

Consider these advantages of Sheffield milk proteins: they are fat-free, pleasing to taste, variable in protein content, white in color, and many are sodium-free In addition, they can serve as excellent dispersing, stabilizing and water-binding agents in many foods. Of course, all meet applicable Federal Food and Drug regulations.

Milk proteins are only one of many products of Sheffield research, all directed toward supplying food processing manufacturers with superior ingredients. Our research department will gladly work with your laboratories to develop new products or improve old ones. For detailed information write Sheffield Chemical Company, Inc., Food Division, Norwich, N.Y.—or to our branch office at 1267 Sixth Ave., New York 19, N.Y.

SHEFFIELD

MILK PROTEIN EDIBLE POWDER
HIGH NITROGEN CASEIN

SODIUM CASEINATE POWDER
CALCIUM CASEINATE POWDER

LEADS THE FIELD IN MILK PROTEINS

A DIVISION OF NATIONAL DAIRY PRODUCTS CORPORATION

FOOD INDUSTRY TOPICS

(Continued from page 36)

type filler, the Dura-Mil is used for applications involving liquids and semi-viscous materials. Write to Turbo Machine Co., Lansdale, Pa.

◆ ◆ ◆

Graver Water Conditioning Co., 216 W. 14th St., New York City, now has available literature on a Graphic panel arrangement for all automatic ion exchange equipment that allows the operator to see at a glance if the system is functioning properly. On the Graphic panel control board is located, in addition to the usual controls, meters, and recorders, a pictorial representation of the ion exchange units and the immediate piping and valves. Each valve representation has two colored lights, one red, one green. When the operation valve is open, the green light is on; when the valve is closed the red light is on. All pipe lines are also lit and colored.

◆ ◆ ◆

A new illustrated bulletin that explains the operation of a new Norelco magnetic-particle test unit called "Portaflux" is available gratis from the Research & Control Instruments Division, North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N.

◆ ◆ ◆

"Packaging Abstracts," distributed in the U. S. A. by Packaging Institute, and heretofore available only to members of the Institute, is now available to firms, libraries, and persons other than members at $35.00 per year. Orders will be accepted by Packaging Institute, 342 Madison Ave., New York 17, N. Y., to start with the first issue available after receipt of the purchase order. Single copies are not available. Each volume of Packaging Abstracts comprises 12 monthly issues plus an annual index. The journal covers all the world's literature, journals, books, patents, and bulletins that pertain to packaging.

◆ ◆ ◆

Manufacturers can now determine if their companies are ready for "Automation" (application of machinery to perform and control automatically and continuously all the manufacturing operations in a plant), according to a new brochure published by T. A. B. Engineers, Inc. (Technical and Business Engineers), Chicago, Milwaukee and Ogden Aves., Chicago 22, Ill. Feature of the pamphlet, "Cut Costs with Automation," is the First Automation Evaluation Chart which will help top executives rate the automation possibilities and potentials of their own plants, including a complete analysis of products, production, costs, and future markets. Copies may be obtained by writing to T. A. B. Engineers, Inc.

◆ ◆ ◆

Details of a new Paper Electrophoresis System including all instrumentation for a standardized operating procedure is described in a new Spinco folder, Form 4R-554. The equipment, manufactured by Specialized Instruments Corporation, 704 O'Neill Ave., Belmont, Calif., and now distributed nationally, is illustrated both in an operating group and in closeup to show special features.

◆ ◆ ◆

Walter Maguire Co., Inc., 60 E. 42nd St., New York 17, N. Y., announces availability of Type SH Cortland Emery Aggregate for surface hardening concrete floors. The new prod-

(Continued on page 40)

Is a link missing in your Quality Control Chain?

But he can *be prepared* in advance to spot the trouble *the moment it occurs* by using

cook-chex

No Food Technologist can tell *in advance* when a batch is going to "go bad."

...MPERATURE SPECIFICATIONS FOR FREE COOK-...ATORS CUSTOM-MADE TO FIT YOUR REQUIREMENTS

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Without obligation, please send me a supply of COOK-CHEX indicator tags designed for use at _____ degrees F., for _____ minutes.

Name _____

Position _____ Company _____

Address _____

City _____ State _____

ASCORBIC ACID MERCK

Gives Your Products Point-of-Sale Appeal

If you market any of the food products listed below, note how MERCK ASCORBIC ACID can improve appearance, taste, or nutritional value. FRUIT JUICES can be fortified with Merck Ascorbic Acid to supply substantial amounts of Vitamin C at all times. FROZEN FRUITS protected against oxidation with Merck Ascorbic Acid look and taste better to flavor-conscious customers. MILK SUPPLEMENTS offer additional nutritional value when they include Merck Ascorbic Acid. FROZEN FISH, high in fat, get customer-appealing protection against rancidity and darkening when Merck Ascorbic Acid is the antioxidant.

Other Merck Products for the Food Industry:

Vitamin A Acetate	Niacin	Tartaric Acid
Riboflavin	Citric Acid	Sodium Benzoate
Thiamine	Sodium Citrate	Vitamin Mixtures

Research and Production
for the Nation's Health

MERCK & CO., INC.
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RAHWAY, NEW JERSEY

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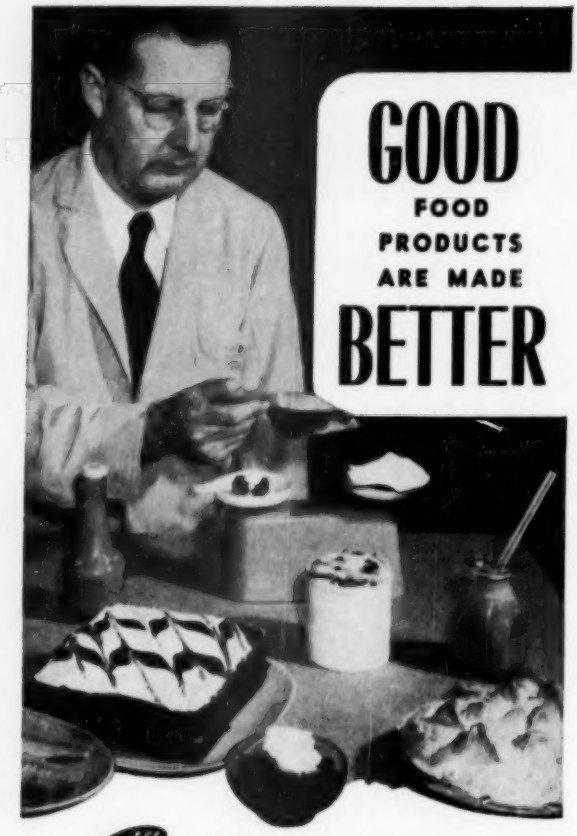

with SeaKem "COLLOIDS OUT OF THE SEA"*

Does your product have all the appetite and sales appeal it needs? . . . Can your manufacturing process be simplified or speeded up? . . . Has a really tough improvement problem got you ready to throw in the towel?

Then it's time right now to discover how SeaKem Stabilizers can help you.

The check list at right shows a few of the positive ways these remarkable colloids are improving dozens of items as widely varied as bakery product stabilizers, chocolate milk, dessert mixes, ice cream stabilizers, pet foods, pie fillings (fruit), puddings, sauces, sausages, and syrups.

Whatever your food product may be, if the function you are interested in is listed, it will pay you to get full information on SeaKem "Colloids Out of the Sea". For prompt, non-obligating recommendations, just write outlining your problem.

Here are a few of the functions being performed by SeaKem Stabilizers for an ever-growing list of food products:

- Binding
- Bodying
- Emulsifying
- Gelling
- Modifying
- Stabilizing
- Suspending
- Thickening
- Custardizing milk and products containing milk solids
- Improving mouth feel and flavor
- Increasing efficiency of component ingredients
- Modifying ice crystal growth
- Physical and anti-oxidant protection

* SeaKem is the registered trademark for the standardized, water-soluble, sea plant extractives manufactured by the Seaplant Chemical Corporation. Refined by rigidly controlled processes which insure dependable uniformity and purity, SeaKem "Colloids Out of the Sea" are light amber to colorless, free-flowing flaky powders. Available in a variety of types suitable for use in either dry or liquid applications, SeaKem Stabilizers have won acceptance on the basis of proven advantages with leading food manufacturers and processors.

Send for latest SeaKem Technical Bulletins

SEAPLANT
CHEMICAL CORPORATION
42 David St., New Bedford, Massachusetts

FOOD INDUSTRY TOPICS

(Continued from page 38)

uct is 100% natural emery, rich in aluminum oxide for hardness and iron oxide for toughness and non-brittleness. It is designed to give longer life and non-absorbent, non-dusting, and non-slip qualities to concrete flooring. Bulletin SH-1-54 describes the new product, and Bulletin 653 contains descriptions of the firm's other emery flooring materials.

◆ ◆ ◆

A hydraulically operated, quick-opening cover is a new operational and safety feature on horizontal and vertical filters manufactured by Niagara Filters Division of American Machine and Metals, Inc., East Moline, Ill. Quick, effortless opening and closing of the filter tank, even seating of the cover, and reduced maintenance costs are some of the advantages claimed for this new accessory. The new quick-opening, hydraulically operated cover is more fully described in literature available from the company.

◆ ◆ ◆

Round-the-clock production techniques in the processing of the polio-fighting serum "gamma globulin," and the design of a weighing device so sensitive it can measure and record the difference in weight between a broad and a narrow pencil line are two industrial developments reported in the current issue of *Instrumentation*, technical publication of Minneapolis-Honeywell's Industrial Division, Philadelphia. The same firm has recently made available its Bulletin 100-C listing all current Honeywell Industrial Division literature. Numbers and titles of all Catalogs, Bulletins, Specification Sheets, and Instrumentation Data Sheets are included. For copies write Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne and Windrim Aves., Philadelphia 44, Pa.

◆ ◆ ◆

Super Freezer doors for use to minus 50° F. are described in a new catalog issued by the Jamison Cold Storage Door Co., Hagerstown, Md. Construction and design details are given along with a valuable check list for picking the right kind of door for the application. Size tables and dimension details are listed for both the walk-in, reach-in, and vestibule type of door.

◆ ◆ ◆

Armour's *Analysis*, June 1954, published by Armour's Livestock Bureau, Union Stock Yards, Chicago 9, Ill., devotes its entire 8-page issue to the review of the progress of "Science in Meat Processing."

◆ ◆ ◆

A scientific "sniffer" which may be able to determine precisely the quality of food by its odor, under development by scientists at the University of California, is described in the August 1954 issue of *D&O News*, published by Dodge & Olcott, Inc., 180 Varick St., New York 14, N. Y. Fine grading of such foods as fish, vegetables, fruit, cheese, butter, coffee, spices, pepper, etc., may one day be accomplished by this laboratory "nose." Farmers might even use it to tell the best time to pick fruit for eating or for canning.

◆ ◆ ◆

A reprint entitled "Rewarding Careers Await Technical Men in Food Industry," by Mr. Frank K. Lawler, editor, *Food Engineering*, is available from that publication. The article appeared in the February 1954 issue of *Food Engineering*.

◆ ◆ ◆

A brochure on Laboratory and Sanitation Controls for Food Processing Plants, detailing the services offered by Bradbury Research Associates, Inc., Waltham 54, Mass., is available from that company.

◆ ◆ ◆

A four-page booklet, "25 Salesense Ideas to Help Make More Sales," developed by Kelly-Read and Co., 508 St. Paul St.,

(Continued on page 42)

Magic Crystals

Now End Flavor Fading In Your Processed Foods

With Zest,® 99+% Pure Monosodium Glutamate, Food Processors Make Foods More Flavorful Than Ever!

AMERICA'S LEADING FOOD PROCESSORS USE THESE STALEY PRODUCTS

Staley's 99+% Pure Monosodium Glutamate—pure, free-flowing crystals that intensify natural food flavors.

Corn Syrup—Sweetose Brand-high conversion sweetener for firmer texture, better flavor.

Corn Oil—A vegetable oil of highest quality for cooking and food processing.

Lecithin—An established emulsifier and antioxidant for the Food Industry.

No need to let heat, pressure and other processing conditions rob food of taste appeal. Zest magnifies the natural flavors without adding any flavor, color or aroma of its own. Whether your products are frozen, dehydrated or canned, Zest brings out all their natural goodness—puts them first on the consumer's shopping list.

A. E. STALEY MFG. CO., *Decatur, Ill.*

Zest — Staley's

Industries Served by Staley Products

BAKING • CONFECTIONERY • ICE CREAM • FOOD PROCESSING

FOOD INDUSTRY TOPICS

(Continued from page 40)

Rochester, N. Y., personnel development specialists, as a public service for salesmen, is available from that firm.

◆ ◆ ◆

Diamond tips, published by Diamond Crystal Salt Co., St. Clair, Mich., and Akron, O., offers a well-salted assortment of news tidbits from the industries.

. . . *meeting hall and conference room*

The 16th Annual Forum of Packaging Institute, to be held at the Hotel Roosevelt, New York City, on October 25, 26, and 27, will feature the following seminars: Testing and Specifications for Packaging Materials; What Industry Is Doing to Educate and Train Its Packaging Employees; Adhesion as an Engineering Function; Problems of Drug and Pharmaceutical Packaging; The Last Word in Package Printing Processes; New Developments in the Formation of Packages from Heavy Gauge Films; Problems Relating to the Newest Types of Shipping Containers; Line Production of Packages with Special Emphasis on Down Time and Factors Affecting This Form of Lost Production; Statistical Methods and Their Application to Quality Control; Controlling Color and Gloss on Printed Packages; Odor and Moisture Control in Packaged Foods; Flexographic Printing. Among the well-known men from the food field who will be speakers are: Mr. J. J. Nicks, Corn Products Refining Co.; Mr. K. F. Lang, H. J. Heinz Co.; Mr. E. J. Monahan, National Biscuit Co.; Mr. J. A. Warren, American Home Products; Mr. E. P. Lee and Mr. L. W. Elder, General Foods Corp.; and Mr. S. Harrison, Kraft Foods Corp.

◆ ◆ ◆

The 28th Fall Meeting of the American Oil Chemists' Society, to be held at the Radisson Hotel, Minneapolis, Minn., October 11, 12, and 13, will feature four symposia: on Detergents, Dry

(Continued on page 44)

Journal . . . . . .
THIS JOURNAL IS PUBLISHED BY THE SOCIETY FOR APPLIED BACTERIOLOGY IN GREAT BRITAIN

of . . . . . .
IT CONTAINS ORIGINAL PAPERS AND SYMPOSIA ON ALL ASPECTS OF AGRICULTURAL AND INDUSTRIAL MICROBIOLOGY

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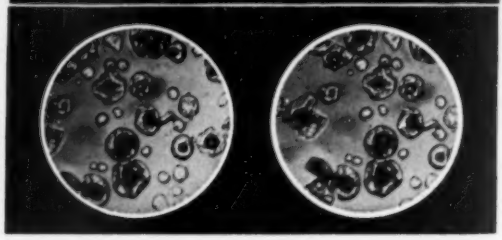
BRADLEY & SON, LTD., THE CROWN PRESS, READING, ENGLAND

P&S
POLVAROMAS
the PERFECT ANSWER to POWDERED FLAVORS



As illustrated in the above photomicrographs, Polvaromas are made through a special P & S process whereby a drop of flavor is entirely surrounded by a protective coating of edible, non-toxic vegetable material. With Polvaromas the flavor is not dried on the surface of a powder, but is locked within. This is proof of your gaining optimum flavor stability.

Here at last is the perfect flavor solution for all food products which are based on a dry composition.

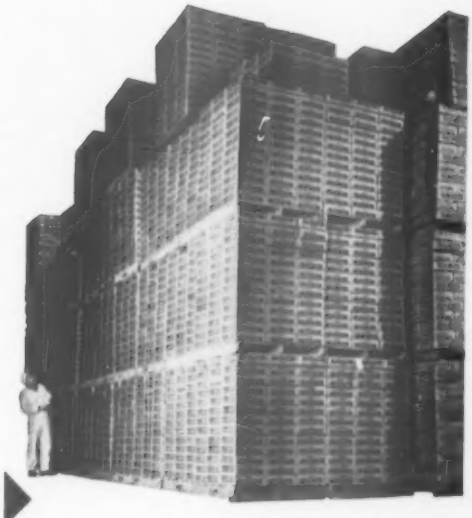
Polvaromas are available in all popular flavors. We shall be happy to submit samples and further technical information for your approval.

USES FOR POLVAROMAS

SOFT DRINK POWDERS · GELATIN DESSERT POWDERS
PUDDING POWDERS . . . . . PIE FILLER MIXES
ICE CREAM MIXES . . . . . ICE & SHERBERT MIXES
DAIRY MILK DRINK POWDERS . . . . CHEWING GUM
CAKE & COOKIE MIXES . . . . . ICING MIXES

P&S POLAK and SCHWARZ
INCORPORATED
667 WASHINGTON ST., NEW YORK 14, N. Y.
CHICAGO • DETROIT • LOS ANGELES • MILWAUKEE • TORONTO

This new booklet



This tower of cases represents a typical eight-hour day's output—242,000 jars of baby food—on a Pfaudler RP-21 Piston Filler at Beech Nut Packing Co.

. . . can show you how to do this ▶

. . . and answer these questions:

Exactly how does a rotary piston filler operate?

- Diagrams and explanation show you how!

How can I lower the cost of cleaning food fillers?

- Booklet shows you how 1 man, using no tools, can do the job in less than ½ hour!

Can you guarantee the speed of filling my products?

- Typical chart gives examples of guaranteed filling speeds!

What fillers are available, and what jobs are they designed for?

- Six well-organized pages on filler operation and accessories give you all the answers!

if *you mail this coupon . . . today!*

Pfaudler

THE PFAUDLER CO., ROCHESTER 3, NEW YORK

Engineers and Fabricators of Food Processing Equipment

Gravity Fillers	Steam Peelers	Vacuum Pans
Piston Fillers	Deaerators	Evaporators

THE PFAUDLER CO., Dept. FT-9, Rochester 3, N.Y.

Please rush me a copy of your new rotary piston filler booklet No. 911.

☐ I am working on a problem in filling.

☐ I want to bring my literature library up to date.

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

FOOD INDUSTRY TOPICS

(Continued from page 42)

ing Oils, Analytical Techniques, and Waste Disposal. About 80 papers will be presented in concurrent sessions.

. . . *building up and branching out*

Red Star Yeast and Products Co., Milwaukee, Wis., and Food Industries Co., Inc., Dallas, Tex., have jointly announced an arrangement whereby Food Industries will produce fungal enzymes in tablet form to be sold to the commercial baking industry as a new and improved Red Star product under the name Star-Zyme. An important result of the new association is the fact that it combines the extensive research facilities and fungal enzyme know-how of both companies.

◆ ◆ ◆

Whitehead Metal Products Co., New York City, for 40 years a supplier of metal products, is now distributing non-metal pipe and fittings made of rigid B. F. Goodrich vinyl plastic by Alpha Plastics, Inc., West Orange, N. J. The pipe is made in ⅛- to 4-inch sizes, and molded fittings in ½- to 2-inch sizes. The manufacturer says larger fittings can be made to order.

◆ ◆ ◆

On August 2, Foster D. Snell, Inc., 29 S. 15th St., New York 11, N. Y., announced the research firm's fourth expansion since 1947. Dr. Snell said that this expansion reflects the fact that more companies are spending more money for research, development, and testing, which bodes well for the national economy as well as that of his own company.

◆ ◆ ◆

A sales development and technical service laboratory for the Du Pont Company's Film Department will be built at Wilmington, Del., at an estimated cost of $1,000,000. The new laboratory will expand Du Pont's program of service to customers in applications and use of cellophane, acetate, and polyethylene films, "Mylar" polyester film, cellulose sponges and sponge yar, and cellulose bands. The program also includes exploration of markets for all Film Department products and investigation of industry's need for new types of films.

◆ ◆ ◆

Arthur D. Little, Inc., announces opening of its Western Laboratories Division (formerly The Merrill Co.) through which all Little research and consulting services are now directly available to West Coast industry. Mr. Chas. G. Harford is technical director; Mr. Raymond E. Byler is business manager of the new Division. Address is 114 Sansome St., San Francisco 4, Calif.

◆ ◆ ◆

Construction of new, ultra-modern laboratories to house its Biochemical Research Department was begun recently at Midland, Mich., by The Dow Chemical Co. Among other activities, the Biochemical Research Department works closely with the firm's agricultural chemicals group on the development, use, and safe handling of fumigants, pesticides, weed killers, and other agricultural chemical products.

. . . *the human element*

Fritzsche Brothers, Inc., New York City flavor house, announces with regret the impending retirement of **Mr. Jos. A. Huisking,** vice president and director. He is also treasurer and director of the affiliate company, Fritzsche Brothers of Canada, Ltd.

◆ ◆ ◆

Two new members of the field staff and changes in the internal staff of the Hoffmann-La Roche bulk Vitamin Division have been announced by Mr. Paul J. Cardinal, vice president. Under the direction of Mr. C. C. Robinson, Vitamin Division sales manager, **Mr. Fritz J. Hopf** and **Mr. Stanley T. Olds** have

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BIG NEWS about FISH STICKS!

New taste test shows that MSG can double consumer preference!

Here's important news for everyone who makes, sells or buys frozen fish sticks.

Famous United States Testing Company, Inc., reports that you can *double* consumer preference for your fish sticks by simply adding MSG at the Huron-recommended level of .18%. This conclusion is based on a scientific taste test (Psychometric) of treated and untreated fish sticks.

What the test revealed

67% of the taste panel preferred fish sticks with MSG added at the .18% level, to 33% who chose the untreated samples. What's more, 67% also preferred MSG at the .18% level, while only 33% went along with the sticks treated with .05 MSG (the "usual" level). This finding completely confirms the .18% level long advocated by Huron's Technical Service.

What the test means to you

Whether you process, sell or buy frozen fish sticks, this test means you can actually "build in" your product a taste appeal that's preferred by twice as many consumers. That's a tremendous competitive advantage which is bound to put your product on top. It spells more sales . . . more profits in today's booming frozen fish sticks market. We'll be glad to send you a free copy of the United States Testing Company, Inc., report.

Don't forget — Huron MSG can heighten the flavor of most frozen foods — meats, poultry and vegetables as well as fish. Write or phone our Technical Service today for all the facts on this easy way to make your brand the one people prefer. The Huron Milling Co., 9 Park Place, New York 7, N.Y.

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FOOD INDUSTRY TOPICS

(Continued from page 44)

joined the Division's staff of field representatives in the Philadelphia and Chicago areas respectively. **Mr. R. Semmes Clarke** and **Mr. John Haase, Jr.**, recently joined the Nutley administrative staff.

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Mr. Robert Waltersdorff, formerly of the Philadelphia Sales District of the Crown Can Division, Crown Cork & Seal Co., Inc., Baltimore, Md., is now conducting the customer field service for the Division's Baltimore territory. In this capacity, he will visit customers' plants and provide technical assistance in the packing of their products. His headquarters is the Division's Baltimore office located in the Munsey Building at Calvert and Fayette Streets.

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Mr. Clifford F. Evers, one of the original pioneers in frozen food research, has been appointed technical service director for Ac'cent (pure monosodium glutamate), according to an announcement by Mr. J. R. T. Bishop, vice president in charge of the Amino Products Division of International Minerals & Chemical Corp., Chicago. Mr. Evers will be in charge of all research and technical aspects of the Ac'cent educational development program.

◆ ◆ ◆

A doctorate degree from the University of Maryland was recently received by **Dr. Eugene J. Gerberg**, director of Insect Control and Research, Inc., Johnnycake Road, Baltimore 7, Md. His thesis was entitled "A revision of the New World species of powder post beetles belonging to the family Lyctidae." These insects are second only to termites as the most important insect destroyers of wood.

◆ ◆ ◆

Announcement has been made of the appointment of **Dr. Laszlo Reiner** as staff consultant to Food Research Laboratories, 48-14 Thirty-third St., Long Island City 1, N. Y., in the fields of pharmacology, toxicology, and medicinal research. Dr. Reiner, an M.D. with a Ph.D. in chemistry, was formerly director of research of the laboratories of Burroughs-Wellcome & Co., and of the pharmaceutical division of Wallace and Tiernan.

◆ ◆ ◆

Dr. Alexander E. Katz, president of F. Ritter & Co., Los Angeles, manufacturers of natural and synthetic food flavorings, essential oils, and aromatic chemicals, is currently visiting Europe and the Near East for the purpose of surveying the various raw material markets and establishing new Ritter agencies abroad.

EMPLOYMENT NOTICES

POSITION WANTED: Biochemist—Food Technologist, Ph.D. 1951, Univ. of Calif., Berkeley. Age 43. Experienced in fermentation, enzymes, vitamins, starch, proteins, brewing and baking. Publications. Excellent research record and executive ability. Employer notified. REPLY BOX 354, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Food Technologist, recent graduate or with 2 or 3 years experience. Nationally known midwestern food processing company has opening in expanding quality control and research department. Write full details immediately. Salary commensurate with education and experience. REPLY BOX 356, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Food Technologist with B.Sc. in Dairy Technology or equivalent, thoroughly familiar with "Standard Methods" procedures. Must have sufficient chemistry to carry out basic analytical procedures without assistance. Starting salary about $4,500. REPLY BOX 353, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Biochemist for work on food chemical problems. B.S. or M.S. man to work in development work on food chemicals. Experience desirable but not required. Southeastern location, well established firm, excellent opportunities. Salary open. REPLY BOX 352, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Food Technologist either full or part time for quality control and product development. Experience in canned meat industry desirable. Location New York City. REPLY BOX 357, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: Food Technologist, M.S. Training in biochemistry, microbiology and nutrition. 16 yrs. diversified experience in meat, frozen foods and cereal products. Desire responsible position in research and development. REPLY BOX 355, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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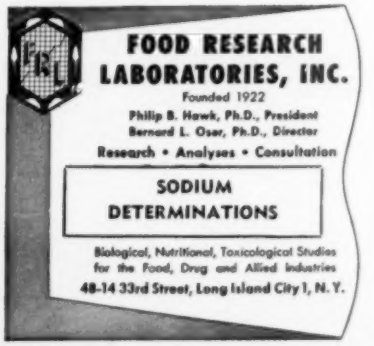
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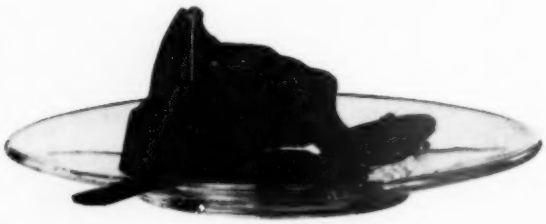

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